PYE'S
SURGICAL HANDICRAFT

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H. W. CARSON

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PYE'S
SURGICAL HANDICRAFT:

A MANUAL

OF

SURGICAL MANIPULATIONS, MINOR SURGERY, AND OTHER MATTERS CONNECTED WITH THE WORK OF HOUSE SURGEONS AND SURGICAL DRESSERS

EDITED BY

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Tenth Edition: Fully Revised.

WITH SOME ADDITIONAL MATTER AND ILLUSTRATIONS

Vel de minimis curat chirurgicus

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PUBLISHERS' PREFACE

A FURTHER revision of Pye's Surgical Handieraft became necessary following the late Mr. W. H. Clayton-Greene's execllent work, which did much to extend the popularity of this favourite manual throughout the currency of the four editions whieh were issued under his editorship.

The Publishers were fortunate in seeuring the eo-operation of Mr. Herbert Carson in the preparation of thc present edition. They dceply regret his untimely death, which oeeurred before the volumc could be issued from the press.

It would not be fitting for the Publishers to attempt to appraise the value of Mr. Carson's editorial serviecs. Suffice it to say that he threw himself with all his heart into the undertaking. It was characteristie of the man, as they knew him, that in carrying the work through thc press, he was partieularly eareful that it should be still "*Pye's* Surgieal Handieraft", not Carson's. He began to write for 'Pye' twenty-two years ago, and the conneetion only eeased with his life. He saw every sheet of the present cdition through the press except the last two, leaving nothing uneompleted but his intendcd Prefaee.

Under such circumstances the Publishers were reluctant to delegate the Preface to another pen, and, having themselves had intimate acquaintance with the work and its Editor from thc eommcncement, they prefcr to givc in the following paragraphs a brief indication of thc principal ehanges which arc to be found in the present edition.

A comprehensive rcvision has been made of the entire volume, while at the same time partieular eare has been taken, as before stated, to avoid saerificing its individuality or unduly increasing its size.

The section on Venereal Diseases now consists of three chapters, and is entirely new. A ehapter is added on Radium Treatment in Caneer; that on X-ray Diagnosis and Treatment has been re-written and re-illustrated. New sections deal with Infected Wounds of the Hand, The Injeetion Treatment of Varieose Veins, Tannie Aeid Treatment of Burns, Thierseh's Method of Skin-Grafting, Treatment of Psoas Abseess, and Ruptured Urethra. The ehapter on Anæsthesia has been modified and amplified, and ineludes a referenee to the reetal administration of Avertin. Other minor changes bring the present edition into line with modern knowledge and praetice. Some methods of treatment whieh are now obsolescent have been disearded, together with a number of illustrations—replaced by a larger number of new ones—the result being to add but twenty-four pages to the last edition.

The Publishers tender sincere thanks to those colleagues of Mr. Carson who aecorded him valuable assistanee in the production of speeial seetions in the work, namely:—T. Anwyl Davies (Venereal Diseases); Leslie Paton and F. A. Williamson-Noble (Eye); Norman G. Bennett (Teeth); Sir W. H. Willcox (Poisoning, Urine Testing); Joseph Blomfield (Anæsthesia); G. Harrison Orton (X-rays); T. Joekes (Blood Transfusion); and D. MeCrae Aitken (the Thomas Splint).

Their thanks are also due to Mr. Harold Dodd, who kindly passed for press the last two sheets after Mr. Carson's decease.

The tenth edition of Pye's Surgical Handieraft is probably the last eontribution to medical literature of a great surgeon who was held in high esteem by his fellow surgeons and others who were fortunate enough to be personally associated with him; it is confidently hoped that the book will receive a renewed welcome from the younger race of surgeons.

Bristol, *December*, 1930.

PREFACE TO THE FIRST EDITION

In this book I have endeavoured to deseribe the details of surgieal work as it appears from the point of view of house surgeons and dressers in surgical wards.

My aim has been, further, to present this work to them, as to men apprentieed to a skilled labour, in whieh exeellenee ean only be attained by the acquisition of manual skill or handicraft; for although surgery is doubtless beeoming more scientific day by day, and although it may even now have come to pass that with the inereasing reeognition of its higher aims, its manipulative side is unduly overshadowed, nevertheless Chirurgery ean never be false to its etymology, χειρ εργον, will never eease, that is, to be a skilled labour, nor will surgeons ever cease to be handieraftsmen.

This main idea I have wished to express in the title I have chosen, and it has been very far from my desire to write in any sense an elementary work on theoretieal surgery. Still, I am eonseious of having been forced in some plaees to treat of abstraet surgieal questions, and to saerifice absolute eonsistency if by so doing I could better explain necessary manipulations.

WALTER PYE.

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[By Thomas Anwyl-Davies]

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SURGICAL HANDICRAFT

SECTION I

ON THE ARREST OF HÆMORRHAGE

CHAPTER I

OF HÆMORRHAGE GENERALLY

WHEN the blood-vessels are divided or torn across, blood escapes in varying quantities—this is primary hæmorrhage; and according to the character of the vessel injured such hæmorrhage or bleeding will be capillary, venous, or arterial.

While the hæmorrhage which results from injuries to the capillaries and veins is rarely serious, there are certain conditions which render it extremely dangerous: these will be considered later. Arterial hæmorrhage must always be regarded as urgent, and in most instances active surgical measures will have to be undertaken to deal with the accident.

Hæmorrhage may be arrested by **Natural Means,** but in the case of the larger vessels such an arrest is usually called **Temporary,** and requires to be reinforced by such measures as will ensure complete and permanent closure of the wounded vessel.

The process of temporary arrest is brought about by several factors: (1) Cut vessels, and especially torn vessels, tend to contract, this contraction occurring much more readily in the case of veins than arteries; (2) Effused blood coagulates, especially if exposed in the air, and the coagulated blood blocks the mouth of the vessel and acts as a fibrinous plug; (3) Hæmorrhage depends upon the force and velocity of the blood-stream, and is therefore much freer in the case of arteries than veins.

After a certain quantity of blood has been lost, syncope comes on. This is a state of faintness, with depression of the heart's action, produced by hæmorrhage and shock, and within certain limits is a fortunate occurrence, since the slackening of the circulation allows time for the formation of clots and for the contraction and retraction of the vessels within their sheaths. Moreover, the coagulability of the blood increases after a certain quantity has been shed.

Permanent Arrest may occur purely as the result of natural processes, but, as has already been said, in cases where the larger arterial or venous trunks have been injured, active measures will have to be undertaken before the condition is free from danger ; these will be studied under the head of 'Arterial Hæmorrhage' (Chapter II).

This permanent arrest depends upon the process of organization of the clot which has formed : (1) In the lumen of the vessel ; (2) In the torn ends of the vascular sheath ; and (3) Upon changes in the wall of the vessel itself. Gradually new connective-tissue cells grow from the vessel's wall into the clot, which may be regarded as a species of scaffolding—these new-formed cells are slowly transformed into mature fibrous tissue, which indissolubly blends clot and vessel wall together until all that is left of the injured end is a tapering fibrous cord. Not until this final stage is reached is the period of danger from recurrent hæmorrhage safely passed, and many are the factors which may intervene to prevent this successful issue. When a vessel has been tied, or when any of the various expedients to be presently described have been made use of, there is always a risk of the bleeding coming on again unless the natural process of organization progresses unchecked, and it must therefore be clearly understood that tourniquets, pluggings, and even ligatures only act in bringing about a favourable state of things in the vessels so that coagulation, organization, and fibrosis may proceed unhindered.

The immediate measures which should be taken to arrest primary hæmorrhage are :—

1. Prompt pressure, digital or otherwise, over the bleeding point or the main arterial channel.

2. Provision for free venous return from the injured part, so that there is no congestion in the damaged capillary area.

3. The recumbent position, unless, as in nose bleeding, a more favourable attitude can be assumed.

CHAPTER II

THE ARREST OF ARTERIAL BLEEDING

THE proceedings to be taken for the immediate arrest of bleeding have naturally to be adopted on the spur of the moment, before detailed examination of the injury, and with the single object of stopping the loss of blood and maintaining the heart's action.

In most instances it will be found that serious bleeding, when it follows a recently inflicted wound, comes chiefly from one or more arteries ; and that unless these can readily be arrested by direct pressure of a pad or plug upon their torn or divided ends, they must be secured by some form of ligature tied round them ; or some other of the plans of constriction presently to be described must be adopted. But in many cases of accidents this is not immediately possible ; while in that of vessels being divided or wounded in the course of a surgical operation, it would be often inconvenient ; so that it is a frequent practice to cut off the blood-supply from the limb or part of the limb which is concerned by compressing the trunk of the vessel against the bone, or in some similar way.

We will begin then by considering four special means of arrest of arterial hæmorrhage by compression.

I.—ARREST BY DIGITAL COMPRESSION.

The procedure which of all is the simplest, in most cases the most efficient, and the readiest in cases of severe arterial bleeding, is the compression of the trunk vessel with the finger above the seat of the injury, against some neighbouring bone. It is of course only applicable in cases of hæmorrhage in certain places, such as in the limbs, the neck, and some parts of the head and face. Moreover, unless relays of capable assistants can be procured, it cannot, in consequence of the fatigue it produces, be continued for more than ten minutes or a quarter of an hour. Long before that time, however, help may have arrived, or some improvised tourniquet (*vide infra*) may be applied.

The great value of digital compression lies in the fact that it can be applied at once.

With regard to the compression itself, practical experience and an intimate knowledge of anatomy alone will enable the surgeon with absolute confidence to place his finger on the spot beneath which the artery is beating, and in the performance there are one or two points to attend to.

He should endeavour as far as possible to compress the vessel only. Great pain is caused by bruising large nerves against the bone, and if

in pressing the artery he at the same time compress the large venous trunks, or with the hands partially strangle the limb, the venous congestion, and therefore the general bleeding, is increased.*

In compressing we should get the artery fairly against the bone, and press directly upon it. In this way a very moderate amount of pressure will suffice.

The position of the hand and finger to be employed will vary, but as a rule the thumb had better be used to make the pressure (*Fig.* 1), and be reinforced if necessary by that of the other hand. The limb must always be raised.

The Position and Compression of Particular Arteries.—The following directions for the digital compression of particular arteries will serve also for their compression by the various forms of tourniquets, whether improvised or of the regulation patterns.

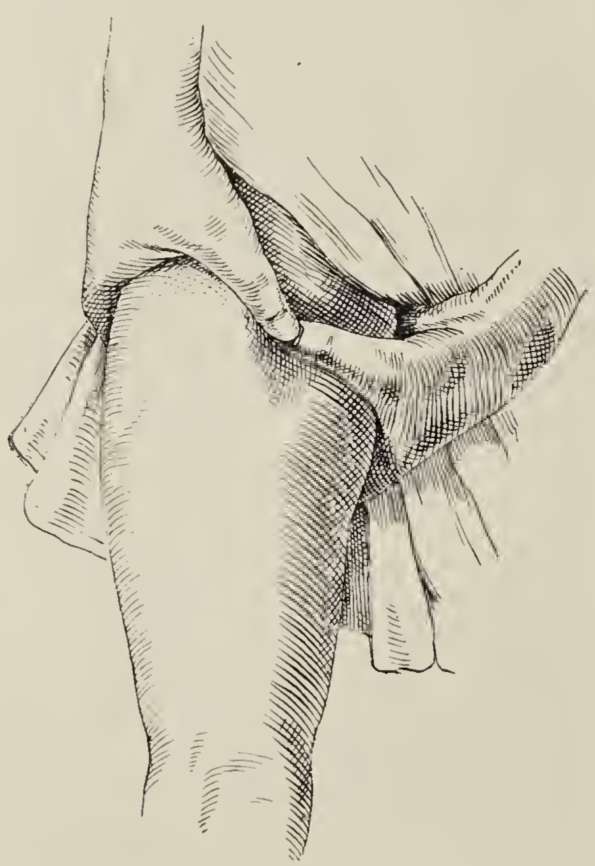

Fig. 1.—Position of Hands Compressing an Artery.

The Arteries of the Head and Neck.—In cases of injury to the scalp, the underlying skull affords an admirable resisting surface for compression, and in speaking of scalp wounds this will be again referred to; but the compression of a main trunk (such as the temporal or occipital on the head), at a distance from the wound, is not often effectual, in consequence of the extremely free anastomosis existing all over the surface. Nevertheless, in some cases compression of the trunk of one of these vessels may be useful. In such a case they are readily found, and a very slight pressure against the bone with the fingers will suffice.

The Occipital Artery on the scalp at first lies behind the mastoid process, and higher up may be felt pulsating, and may be compressed half an inch behind, and on a level with, its base.

The Temporal Artery splits up into its main divisions soon after it passes over the zygoma, and should therefore be compressed against that process of bone immediately in front of the tragus of the external ear. Some of its branches may also be felt, and may be compressed higher up on the frontal bone.

* At the same time it may be mentioned that in the case of a child, or a small limb, it is often not a bad plan to grasp the whole limb firmly with one or both hands and strangulate everything completely. It is the middle course which is here the most unsafe.

The Arteries of the Face, like those of the head, anastomose so freely that the compression of their trunks only incompletely arrests the circulation in their branches. It is, however, frequently necessary to compress either the facial trunk or its coronary branches, as they encircle the mouth. The trunk of the facial artery may be easily found an inch in front of the angle of the jaw, and may be compressed there.

The Coronary Arteries form an exception to the rule of making digital compression against bone, for they are best compressed between the fingers introduced into the mouth, and the thumb on the face. They run round the mouth close beneath the mucous membrane and about a third of an inch from the border of the lips. Their compression is often required in cases of operations or cuts about the lips, and may then be effected between the blades of a pair of bulldog forceps, or by the use of special 'harelip' forceps, of which there are one or two patterns.

In the centre of the neck the only artery which ever has to be compressed is the **Common Carotid,** and the operation requires considerable care, in consequence of the proximity of structures which may not themselves be safely pressed on, such as the vagus nerve, jugular vein, or trachea.

The thumb should be placed over the artery at the level of the transverse process of the sixth cervical vertebra, which is about $1\frac{1}{2}$ inches above the sternoclavicular articulation ; pressure should then be made *inwards* and backwards. In this way the artery is forced away from the vein and nerve, and is compressed against the transverse process or the 'carotid tubercle.'

The Third Portion of the Subclavian is the only one which it is possible to compress satisfactorily, and it is here sometimes very difficult, sometimes very easy, to occlude.

The bone against which it is to be pressed is the upper surface of the first rib, immediately outside the tubercle for the insertion of the scalenus anticus. In children or thin people, pressure behind the clavicle downwards and *backwards,* at the inner margin of the subclavian triangle, will control the circulation, no matter what the position of the limb and neck may be ; but in even moderately fat people it will be necessary to depress the clavicle and shoulder, to bring the artery near enough to the surface. This is usually easy enough to do, but it occasionally happens, in the course of operations about the axilla or shoulder, that the limb is required by the surgeon to be raised, while the assistant in charge of the vessel would prefer that it should be kept depressed. Especially does this happen in amputation at the shoulder-joint, where, just at the moment when efficient pressure is most required (i.e., just after the limb has been removed), the clavicle, freed from the downward drag of the arm, rises in the neck in a very exasperating fashion.

Various devices, such as the handle of a door key, properly padded, or a surgical 'key' of a somewhat similar form, have been devised

to meet the difficulty, and it is sometimes advisable to divide the skin, platysma, and fascia over the triangle (as a preliminary to operative proceedings on the axillary artery), so that the finger may be placed effectually on the artery. This may be readily done by dragging the skin downwards, and dividing it on the clavicle, as in the first stage of the operation for ligature of the subclavian.

This incision is sometimes, no doubt, absolutely necessary, but with regard to the use of the key, nothing is so effective a compressor as the thumb, if it be put in the right place. The mistake which is generally made is either making the pressure far too much outwards, near the acromion, or else not sufficiently backwards as well as downwards.

Axillary Artery.—The first portion can hardly be reached for compression except after incision below the clavicle. The lower half of the second, and the third parts, however, are tolerably superficial, and can be compressed in the armpit, if that region be exposed by raising the arm. The pressure is made against the humerus in the same manner as in the following instance, and the vessel can be localized quite easily, as it crosses to the outer side of the axillary space, and then lies amidst the trunks of the brachial plexus, with the coraco-brachialis to its outer side.

Fig. 2.—Digital Compression of the Brachial Artery.

Brachial Artery.—This artery probably more frequently requires compression than all the others put together, by reason of the great number of accidents to which the upper limb is liable.

It may practically be said to be subcutaneous in its whole length, and may be compressed very readily against the humerus. The inner edge of the biceps, which overlaps it in the middle third, is the guiding line for the vessel.

It is inadvisable to follow the advice given in some text-books, viz., that the inner seam of the coat sleeve is a guide to the brachial artery of the wearer.

The method usually employed is shown in *Fig.* 2.

In flexion, too, of certain of the joints, we have a most valuable means of stopping arterial bleeding.

The position of the brachial artery at the elbow, of the popliteal behind the knee, and of the femoral at Poupart's ligament, are such that forcible flexion of elbow-, knee-, or hip-joints, combined with

placing a firm pad in the hollow of the joint, will, in many cases, completely stop the blood-supply to the limb.

The flexion must be forcible, and may be maintained by fixing the limb with a bandage. An example of its application will be adduced *apropos* of bleeding from the palm of the hand.

At the bend of the elbow the artery may be compressed by the fingers, but not easily, and therefore arrest of hæmorrhage by flexion is preferable.

In the forearm also, except at the wrist, the circulation in the **Radial** and **Ulnar Arteries** can hardly be controlled by any means short of strangulation. At the wrist, however, both arteries become superficial, the radial somewhat more so than the ulnar. The former lies between the tendons of the flexor carpi radialis and the supinator longus, the latter between the radial border of the flexor carpi ulnaris and the flexor sublimis, and here they may be readily compressed. The digital compression of the palmar arches is inconvenient, and the pressure is usually made in other ways. (*See* " Wounds of Palmar Arch," p. 19.)

Abdominal Aorta.—The digital compression of this artery is in some cases not so extremely difficult as is often supposed. It can generally be effected in children unless they are very fat, and in adults if they are thin, have lax abdominal walls and a bold anterior vertebral curve, and in women, especially those who are sparely nourished and have borne children.

The spot where this compression should be made is a point three-quarters of an inch above a line drawn across the abdomen from one iliac spine to the other (the level of the aortic division into the two iliacs), and a little to the left of the middle line. But before pressure is made, the exact position of the artery should be ascertained, for frequently it is in the middle, or may even deviate somewhat to the right.

The digital compression is best and most readily made by the middle and forefinger of one hand, beneath which a small pad of lint should be placed, reinforced by the pressure of the fingers of the other hand. Pressure on the inferior cava trunk must be avoided as much as possible.

Compression of the abdominal aorta is employed by some surgeons during the operation of amputation at the hip-joint. The best method is that of Macewen. An assistant, standing on a chair, out of the way of the operator, places a pad of lint on the abdomen in the position of the lower part of the abdominal aorta ; he then places his hand—or, in a stout subject, his closed fist—on the pad, and, bending down, brings his right knee on to the compressing hand. In this manner sufficient pressure can be brought to bear on the vessel without fatigue, and with due care no harm can result.

Of all the methods devised for the control of hæmorrhage during amputation through the hip-joint this appears to be the most certain.

Wyeth's pins are known to slip frequently. Davy's lever has been the cause of such serious injuries that it has fallen into disuse ; while even preliminary ligation of the common femoral fails to be quite effective, since it has no control over the gluteal and sciatic vessels.

Lynn Thomas has invented a special forceps of the greatest value in checking bleeding during amputations at the hip and shoulder. Of the two blades, one is probe-pointed, and this, in an amputation of the hip, is thrust across the limb close to the bone from an external incision to the inner side. The forceps are then closed, and in this manner the main vessels are firmly compressed, and bleeding is controlled while the limb is being removed. A second pair can be used on the posterior flap.

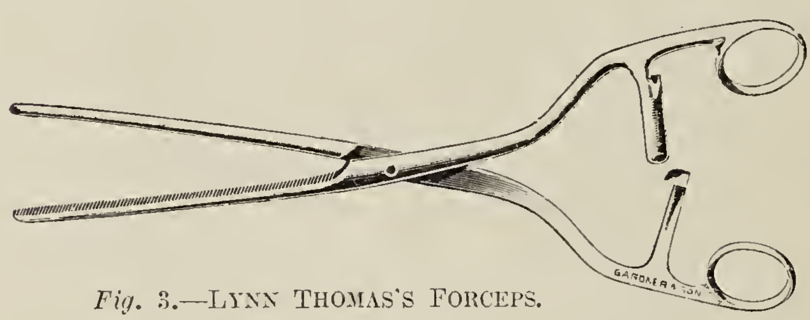

Fig. 3.—Lynn Thomas's Forceps.

The actual time during which compression of the abdominal aorta is required cannot be at the outside more than five minutes, and during that period the whole blood-supply to the lower extremity is checked, and if ordinary care be exercised in the compression of the vessel no damage will be done to the viscera.

Absence of pulsation in the common femoral will indicate that the compression is sufficient.

Common Femoral Artery.—The compression of this artery as it lies over the arch of the pubes is frequently required. In this situation the circulation may be completely controlled by making pressure directly backwards, i.e., at right angles to the surface, midway between the pubic symphysis and iliac spine.

Care must be taken to avoid pressure on the vein as far as possible ; this is best done by putting a small pad of lint underneath the finger. Frequently, however, even when they come through into the thigh, the vein is so far behind the artery that it cannot escape the pressure.

The inguinal glands, too, as they lie parallel with Poupart's ligament, must be avoided, and if they are enlarged, this is sometimes very difficult.

The line of the *Superficial Femoral Artery* is one taken from the point above mentioned, between the symphysis and anterior superior iliac spine, and the adductor tubercle of the femur. When the knee is slightly flexed, and the thigh rotated outwards, firm pressure all along this line will generally succeed in stopping the current of blood ; but as the artery gets deeper in its course, more and more force will be required. The artery cannot be pressed directly against the bone.

Popliteal and Tibial Arteries.—As in the case of the brachial artery at the bend of the elbow, so with the popliteal, digital compression is very inefficient, while the circulation may be readily stopped by flexion. If a firm pad about the size of a hen's egg be placed in the hollow of the knee, and the knee be then bent up on it, the circulation will be quite stopped.

By any means short of complete strangulation of the limb, it will not be found possible to compress either the *anterior or posterior tibial* vessels in the legs ; but the posterior one becomes quite superficial as it lies a little internal to the middle of the hollow *between the heel and the inner ankle,* going with the nerve beneath the annular ligament, between the common flexor of the toes and the special flexor of the great toe.

The Dorsal Artery of the Foot, the continuation of the anterior tibial, may be felt and compressed against the astragalus, scaphoid, and cuneiform bones, between the extensors of the big toe and of the other toes.

II.—ARREST BY STRANGULATION OF THE LIMB.

Esmarch's Bandage and Tube.—The process, generally known by the name of Esmarch's bloodless method, consists in first of all emptying the limb of its blood by rolling a long indiarubber bandage from below upwards to the spot where it is wished to control the circulation. At this spot a stout indiarubber tube two feet long, with a hook at either end, is passed round the limb, sufficiently tight to strangulate all the vessels, and the ends of the tube are then hooked into each other (*Fig.* 4). The india rubber bandage is then removed, and the limb, thus rendered bloodless, will remain so until the tube is taken off.

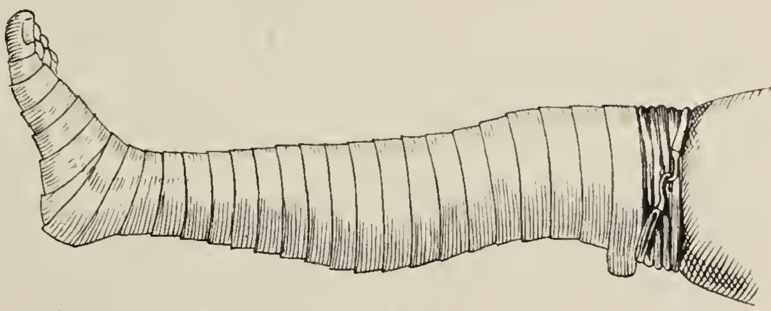

Fig. 4.—Esmarch's Bandage and Tube Applied.

This method is simple enough, and with ordinary care all chance of bleeding is prevented. It is especially useful in such operations as the removal of sequestra, scraping or gouging carious bone, etc., where it is important to have the exposed parts as dry and bloodless as possible ; but it will also serve in the place of a tourniquet in amputations, or in other cases where it can be applied at some little distance from the seat of operation.

The strangulation by this method is so complete, veins, arteries, and capillaries being all compressed, that it is not safe to allow the tube to remain on long. Its use therefore is not fitted for the restraint of accidental hæmorrhage, except as a temporary measure, and indeed in some very prolonged operations it is wise to remove the tube before the operation is finished

When the Esmarch's bandage has been used during an operation, and only general oozing is expected to occur in the wound, it is generally convenient to apply the dressings, using such pressure as may be required, *before* the tube is taken off, for the absolutely bloodless condition of the small vessels causes a temporary loss of tone in their walls, so that when the blood current is allowed to flow into them again, they are for a time much dilated, the whole limb becomes injected, and unless the wound has already been bandaged up, and elastic pressure applied by means of numerous layers of wool, there may be a very brisk flow of blood and a corresponding delay in the dressing. This applies only to the smaller vessels; arteries large enough to give trouble should be secured by forceps and ligatured before taking off the tube.

There has been latterly an increasing desire to simplify Esmarch's procedure, and to do away with the indiarubber bandage, while retaining the tube. It is found, if the limb be raised and the larger veins emptied of blood by the passage of the hand along the limb towards the trunk, that the latter may be rendered nearly bloodless, and that the application of the tube alone is able to keep it so.

The limb should simply be raised, before putting on the tube, in cases of septic inflammation or malignant growth, as morbid products may be forced into the blood-stream if pressure be applied over the affected area.

The tubes used for encircling the limb should always be tested before they are used, for they are very liable to crack or break unexpectedly, especially at the ends where the hooks are fastened.

In cases of operation about the shoulder or hip the tube may very usefully be put on in the form of a figure of 8, and in this way even such operations as amputation at the shoulder or hip joint have been rendered almost bloodless. The plan succeeds best where there is much emaciation.

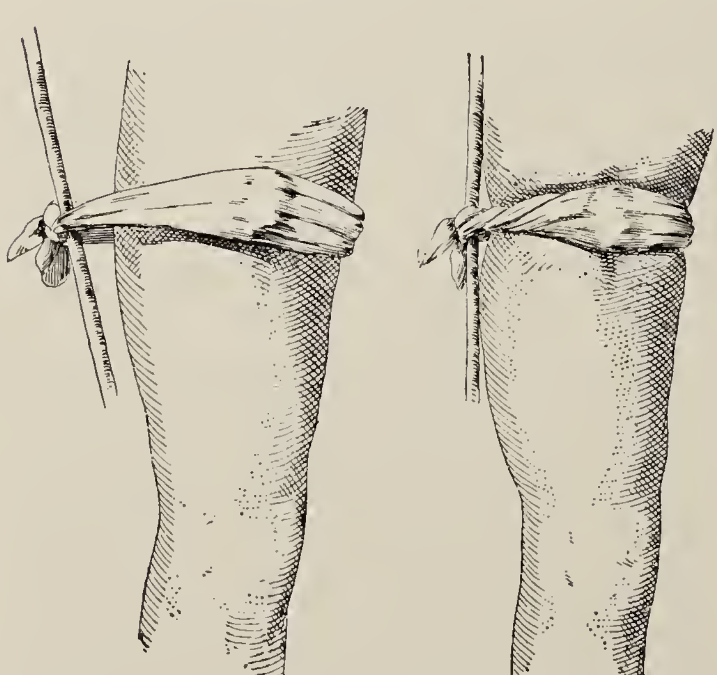

Fig. 5.—The Improvised Tourniquet or 'Garrot'

III.

ARREST BY TOURNIQUETS.

A tourniquet is, properly speaking, an apparatus for screwing down a pad upon a vessel. Practically, however, the term is applied to any means by which pressure can be put upon a vessel and mechanically maintained.

The **Improvised Tourniquet** is an efficient and ready improvement on the time-honoured method of stopping bleeding from any part by

tying something round it, somewhere between the wound and the heart, tightly enough to strangulate all the tissues.

In the improvised tourniquet special pressure is put upon the main artery, and therefore the force required is very much less, and the venous return is at least not wholly obstructed.

Its manufacture and application are simple enough. A handkerchief is taken, folded up like a cravat, and a piece of cork or wood, or a pebble, is inserted between the folds, so as to act as a pad. This pad is placed over the artery, and the cravat *loosely* knotted round the limb, the knot coming on its outer side (*Fig.* 5). An umbrella, or ruler, or any moderately strong rod or stick, is then passed between the limb and the knot, and twisted round. The leverage thus obtained is very great, and the amount of compression must be estimated, or it may be afterwards found to have been damaging the tissues. Care should also be taken that the skin is not pinched at the point where the twisting is done.

This form of tourniquet is known also by the names of the 'Garrot,' or the 'Spanish Windlass.'

The best tourniquet has been devised by Sir L. Cheatle—it is expensive but most efficient (*Fig.* 6).

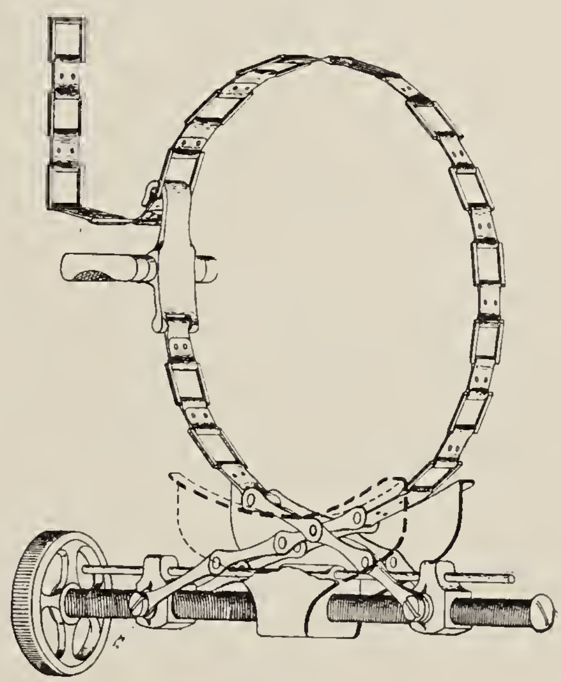

Fig. 6.—Sir L. Cheatle's Tourniquet.

Elastic Tourniquet.—In addition to the elastic band used in Esmarch's method, which has been already described, an improvement has lately been introduced, viz., a small piece of wood with a groove in it, smaller in calibre than the elastic band. After one firm turn has been taken round the limb, the band, while stretched, is passed into the groove from either side. The relaxation and swelling of the india-rubber holds the band quite securely.

If more than one turn round the limb is required, care should be taken that the skin is not pinched between the turns of band. It was partly to do away with this latter objection that Mr. Pollard introduced a *Flat Rubber* tourniquet, which has the additional advantages that it does not constrict the deeper tissues so extensively nor cause any abrasion of the skin.

If the ordinary round rubber tourniquet is used, a piece of lint should be placed between it and the skin, so as to prevent abrasion.

IV.—ARREST BY LIGATURE OF VESSELS.

It would be difficult to mention an improvement in the art of surgery which is greater than the introduction of the practice of tying the mouths of vessels. This was introduced and advocated by

Ambrose Paré,* to whom the credit of the advance is due, although he admits the idea was suggested to him by some observations of Galen.

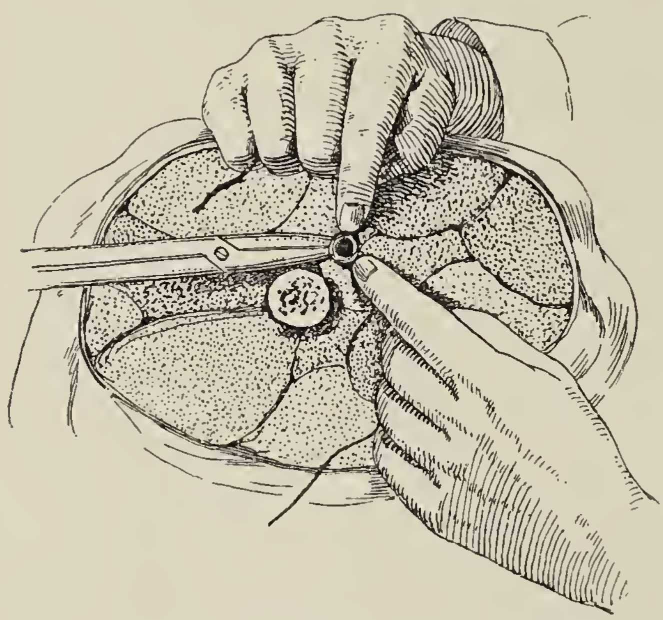

Fig. 7.—LIGATURE OF AN ARTERY. (Position of Hands.)

There are three principal methods of putting a ligature on a divided artery :—

1. Seizing it, and it only, with a pair of forceps, holding it up and tying a ligature of some kind round its mouth in a reef knot (*Fig.* 7). In catching the vessel it should be taken up as cleanly as possible, with none of the surrounding tissue, and slightly drawn upon. The ligature should then be thrown round the forceps, slipped on to the vessel, and tied tightly in a reef knot ; this will be referred to later.

2. Passing a sharp curved needle in a handle, called a tenaculum, beneath the vessel as it lies in the tissues, and then, after raising up the vessel and its surroundings, putting a ligature around all, below the needle, which is itself withdrawn after the knot has been tightly tied.

3. A third way (*Filo-pressure*) consists in passing an eyed tenaculum beneath the vessel near its open mouth. The needle may be threaded, before or after it is passed, with a catgut or silk ligature, which may then readily be tied over the vessel and the small amount of tissue which will be included in the noose, as shown in *Fig.* 8. These two latter

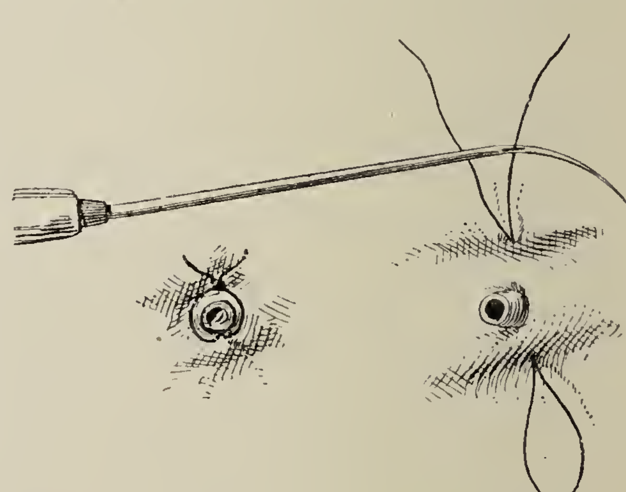

Fig. 8.—FILO-PRESSURE.

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* Paré, when serving as barber-surgeon in the French army in Lombardy, circa 1536, began the practice. In his account he says : " Wherefore I earnestly entreat all Chirurgians that they would (being admonished) give over that cruel and butcherly kind of curation, and practise this which I have prescribed, taught me, as I interpret it, by the suggestion of some good angel. For I neither learned it of my masters, nor of any other man, only I read in Galen, in the first book of his 'Methods,' that to stay a fluxe of blood, there is no remedy so present as to tie up those vessels that bleed, towards their roots, that is towards the liver and the heart. Now I conceived that this doctrine of Galen's for the binding and sewing of veins and arteries in fresh wounds might well be used in the like vessels after a dismembering, and so I put it in practice."

methods are very serviceable in bleeding from scalp wounds, where the relation of the vessels to the tough tissue of the scalp renders simple ligation a matter of difficulty.

Forci-pressure.—This name more especially designates the use of a pattern of self-closing forceps suggested by Sir Spencer Wells, for the purpose of checking temporarily the bleeding from small arteries and arterioles in the course of an operation. Of recent years many modifications have been suggested. Lawson Tait brought in the use of sharp-pointed forceps, by which the accidental inclusion of the blades by the ligature is more readily avoided ; while Greig Smith introduced the plan of making the teeth run parallel to the outside of the blades, by which he claimed greater holding power, and less liability to slip.

In spite of these claims, however, the pattern which goes by the name of its inventor, Spencer Wells (*Fig.* 9), is in almost universal use. Not only may these instruments be used to check bleeding from small vessels during the course of an operation, but in the case of arterioles the pressure exerted is usually sufficient to prevent any further bleeding without the necessity for the application of a ligature. Again, the method of *Torsion* may be applied by means of these forceps, which have therefore superseded a special form of torsion forceps at one time employed solely for this purpose ; and, lastly, they are sufficiently powerful to be of use in seizing a large trunk vessel during an amputation, the vessel being secured with a ligature after the limb has been removed.

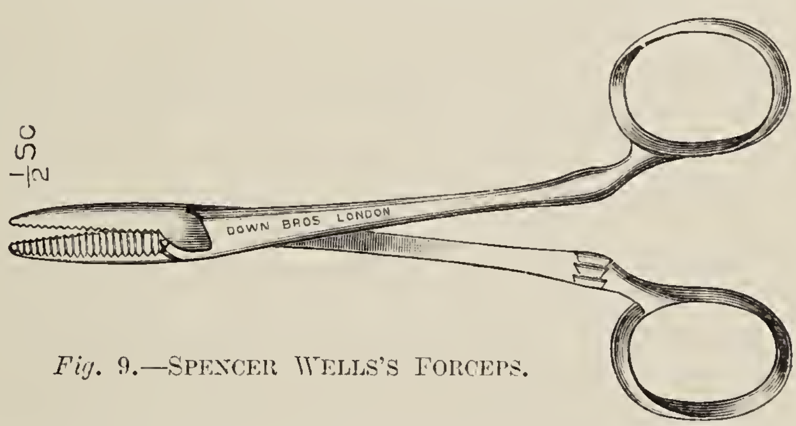


Fig. 9.—Spencer Wells's Forceps.

Torsion.—In machinery accidents, where a limb has been very badly injured, or, it may be, completely torn from the body, it generally happens that there is little or no bleeding from the large arteries divided across ; and if these are examined they may often be seen pulsating quite down to their extremities, which yet are as firmly closed as if they were ligatured.

The explanation is that the vessels have been *pulled* asunder, and that in this pulling, the two inner coats have first parted, while the external coat has only yielded after considerable extension. The aperture of the tube is therefore narrowed before it finally gives way and the vessel comes in two. The outer coat afterwards retains its narrowed condition, and the elastic ones inside retract. These inner coats therefore will be thickened to such an extent that their sides will come into contact within the narrowed outer coat of the vessel and will effectually close it up.

These properties possessed by the coats of the vessels were first

applied to their artificial closure when divided by Amussat in 1829, and soon afterwards by Velpeau, since whose time it has been known as the method by 'Torsion.'

In this proceeding the vessel is not pulled asunder, but the end is *twisted round* many times. The inner and middle coats are thus broken across, and by retracting become thicker, as above described. The narrowing of the outer coat of the vessel is effected by the continuous twisting. The value of this method of arresting hæmorrhage from small vessels is now well established.

Some surgeons twist the vessel until the part in the forceps comes away; others give six or eight turns only, probably the preferable plan.

For this treatment to succeed, *the arterial coats must be free from disease*, such as atheroma, or those more insidious forms of arteritis present in chronic syphilis or gout. When first introduced in the days of the old silk ligature, the advantage of having no foreign body hanging out of the wound was very great; nowadays the twisted end of the vessel is in just the position of a catgut ligature cut short: both, in healthy wounds, will be absorbed, and neither can be regarded strictly as foreign.

The Materials used in Ligation are silk, hemp, catgut, and some other animal materials, as kangaroo tendon, or ox aorta. At the present time silk, thread, catgut, and kangaroo tendon alone need to be considered.

Silk was in former times the most esteemed as being the easiest of application, and is still extensively used: most commonly, the variety known as Chinese twist. It is made in several sizes, but those most frequently employed are the ½, 2, 4, and 6.

The preparation of silk should be as follows:—

1. Placed in ether for twelve hours.
2. Placed in alcohol for twelve hours.
3. Boiled for ten minutes in 1–1000 colourless neutral solution of corrosive sublimate.
4. Wound with clean hands round spools.
5. Spools boiled in 1–1000 sublimate solution for ten minutes just before operation.
6. Ligatures are then handed out of the sublimate solution in which they were last boiled (*Kocher*).

Thread is prepared in the same way.

Catgut and *Kangaroo Tendon* are rendered sterile in the following way: Several pieces of the required length are placed in a bottle with pure oil of juniper berries, taking care that they are completely covered. In this they are left for twenty-four hours, the bottle being well corked; when removed they are put into 95 per cent alcohol, in which they can be kept till required. It is as well, however, to keep constantly supplying fresh lengths rather than to make a large quantity at a time (*Kocher*).

Von Bergmann recommends the following method of preparation. Soak the gut in ether for twenty-four hours to remove the fat, and then in a solution composed of corrosive sublimate 10, absolute alcohol 800, distilled water 200. Renew this at the end of twenty-four hours, and again in forty-eight. The gut is kept in alcohol if it is required stiff ; 20 per cent of glycerin is added if a softer variety is wanted.

Probably the most satisfactory way of preparing catgut is by the xylol method recommended by Mayo Robson, or the more modern formalin method.

Xylol Catgut.—Raw catgut is placed in xylol in a metal box with a screw cap—Mayo Robson's cylinder. The cylinder is screwed up tightly, and then put into boiling water for thirty minutes. The cylinder is unscrewed, and the catgut placed in 5 per cent phenol in spirit. Catgut so prepared is sterile, but is very soft.

Formalin Catgut.—Raw catgut is soaked in ether for twenty-four hours, and then in 5 per cent formalin for a like period. It can now be boiled in water for ten minutes, and after the boiling is kept in 5 per cent phenol in spirit.

Iodine Catgut is now largely employed. It is prepared as follows. Take raw commercial catgut, wash in ether for twenty-four hours to remove fat. Then wind on glass plates and place in solution made up as follows :—

Potassium Iodide	1 part	Water	100 parts
Iodine	1 part		

Keep the catgut for eight days in the solution before use, and prepare only small quantities at a time, as it gets brittle if kept too long.

Catgut, sterilized in tubes, is now readily obtainable, and is so uniform and reliable if the best makes are employed that it has replaced other varieties.

KNOTS.

Among the smaller but necessary accomplishments of the complete surgeon must be reckoned the art of making a '**Reef,**' '**Bow,**' or '**Slip Knot,**' or '**Clove-hitch**' neatly, quickly, and firmly. The importance of this need not be insisted on, for in surgery very literally and very often it happens that life hangs on a thread, and the results may be disastrous if this be insecure. But we believe that to describe in words the actual movements of the fingers in making these knots would be only waste of time ; it is a knowledge which each student must acquire for himself by practice after he has been shown how to do it.

Fig. 10 shows a cord tied in a *Reef-knot* ; *Fig.* 10a a *Granny* ; *Fig.* 10b a *Clove-hitch,* which in the left is half made, and in the right is shown completed, by placing the loop *a* in front of loop *b* ; *Fig.* 10c *Surgeon's knot.* Where firmness is wanted, as for the ligature

of a vessel, and for all ordinary purposes of knotting, the *Reef* is the one for surgeons to use—the *Granny*, never—and the dresser must go on practising the manœuvres until his fingers acquire a perfect automatic skill, so that he never has to think of their individual movements. The *Clove-hitch* is very useful when a pull upon any part is required ; as, for example, in dislocations of the shoulder, when a jack towel is fastened by this knot round the arm. Its great advantage is that it gets firmer the more it is pulled upon, yet it can be loosened in a moment. Moreover it has no tendency to slip. There are one or two ways of making it, all practically coming to the same thing, but the main idea and purpose of the knot can be gathered from the figure.

Fig. 10.
Reef Knot.

Fig. 10a.
Granny Knot.

Neither time nor space need be wasted in discussing the virtues of the bow or half-bow ; other knots well known to sailors or builders, as the carrick bend, bowline, weavers' knot, etc., are not used in surgery, but what is known as the '*Staffordshire Knot*' is a very useful one for securing the cut end of a vascular pedicle by transfixing it with a double-threaded needle on a handle, and slipping the loop over the stump down to the entrance of the threads into it (the needle having been withdrawn). One of these entering threads passes over and the other remains under the loop, so that they can be tightened, one first and then the other, and lastly must be tied in a reef-knot, so that both halves of the stump are simultaneously but separately constricted by the single string and knot (*Fig.* 11).

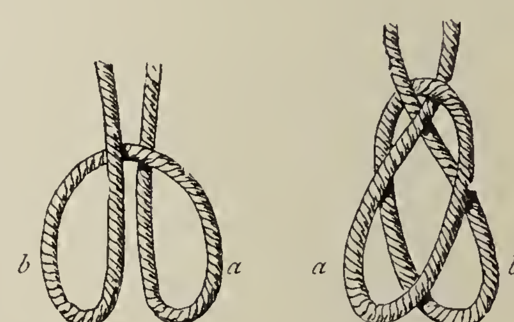


Fig. 10b.—Clove-hitch
(half made, and completed).

In **Tying any Artery** the following rules are to be followed :—

1. The artery is to be cleaned carefully and with as little damage to the walls of the vessel as possible, since, if the artery is stripped too freely from the surrounding sheath, healing will not take place so readily, and hæmorrhage may occur. For this reason it is better, when using an aneurysm needle, to pass it unthreaded round the vessel, to thread it, and then withdraw it.

Fig. 10c.
Surgeon's Knot.

2. If the artery is tied in 'continuity,' a moderately stout ligature should be used, and in the case of large arteries the ligature should

be tied so that the lumen of the vessel is obliterated without rupture of the inner and middle coats.

The modern method of ligaturing the vessel in two places, and dividing it between these points, in order to put an end to the 'anatomical tension' of the vessel, must be employed with caution. Unless the ligatures are very carefully applied they may slip, and if this accident occurs in a deep wound, there may be great difficulty in securing the vessel.

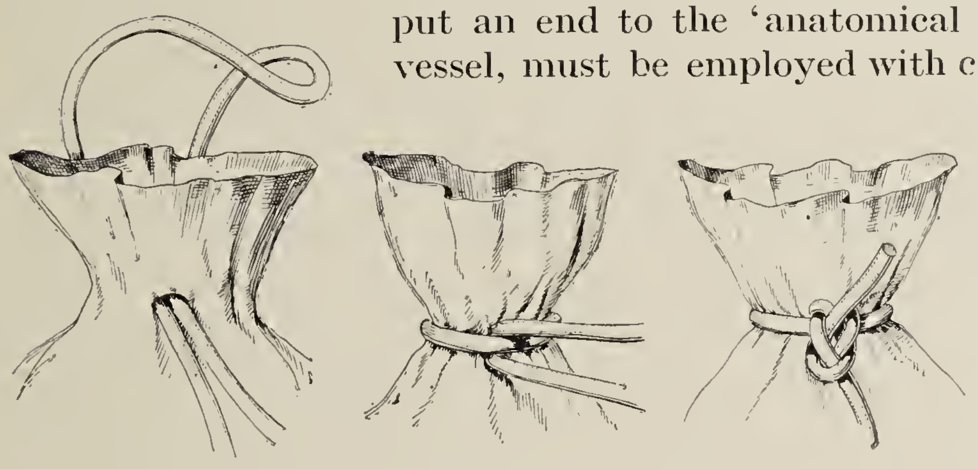
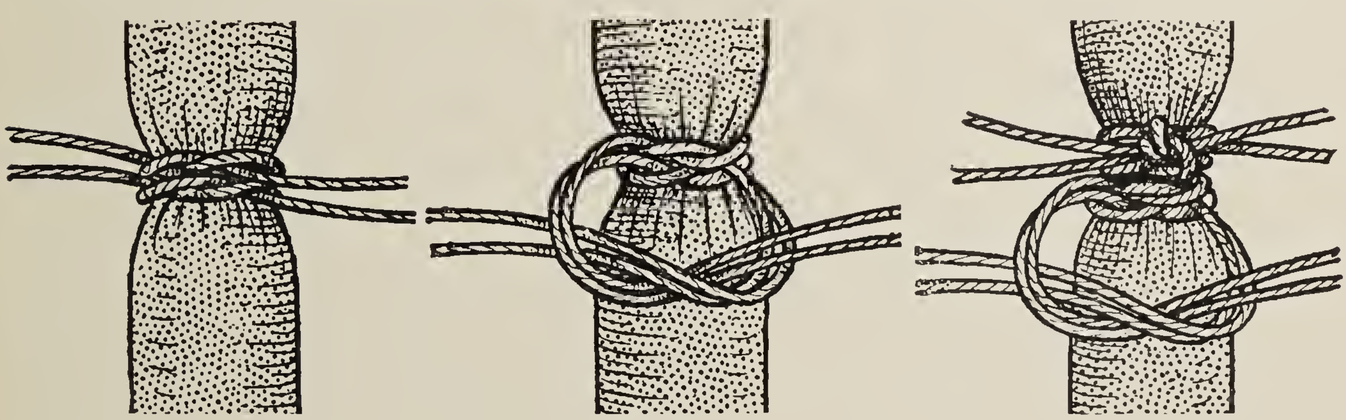


Fig. 11.—Staffordshire Knot.

3. A surgeon's knot should be used, the double turn preventing the ligature from slipping before the knot is completed.



A B C

Fig. 12.—The 'Stay-knot' of Ballance and Edmunds.
(By permission from Burghard's *System of Operative Surgery*.)

In A the first loops of the two ligatures have been tied. In B the two ends on each side are made to form the second loop of the knot, which is shown completed in C, in which a second pair of ligatures is being applied beyond it.

Ballance and Edmunds's *Stay-knot* is very valuable where a ligature tends to slip or become loose from arterial pressure (*Fig.* 12).

CHAPTER III

OF CERTAIN SPECIAL KINDS OF HÆMORRHAGE AND THEIR ARREST

CAPILLARY hæmorrhage is rarely serious ; occasionally, when inflamed and highly vascular tissues are divided, there may be a furious rush of blood from the congested vessels. Free irrigation with a weak antiseptic or the proper application of pressure is nearly always sufficient to bring about its arrest. In some rare cases special measures will have to be adopted (*see* 'Hæmophilia,' p. 38).

During the course of operations on the brain, oozing from small vessels in the dura and bone is very trying, and as it is the surgeon's object to obtain as dry a wound as possible, every effort must be made to secure hæmostasis.

In the case of capillary oozing from the dura mater, a small piece of muscle or fat, snipped off from surrounding structures and applied to the bleeding point with gentle pressure, is wonderfully effective. This living tissue discharges a substance which has a powerful effect in aiding clotting. In the case of bone the same means may be tried, but it is often necessary to plug the opening with a small spicule of wood (sterilized) or with Horsley's antiseptic wax.

Hæmorrhage from an Imperfectly Divided Vessel.—If this form of bleeding be not efficiently arrested it is always troublesome, and sometimes even dangerous. It most commonly occurs on the scalp, or from a wound in the cleft between two fingers, or from the artery of the frænum. Again, when the transfixion method of amputation was more common than it is now, the vessels were apt to be split, instead of being cleanly divided by the knife. This was a frequent cause of secondary hæmorrhage.

The bleeding is obstinate, because the process of its natural arrest is interfered with ; for the cut edges of the wound in the arterial coats retract as far as they can, and this retraction keeps open the orifice in the vessel, instead of tending to close it. The tube thus being only half cut across cannot retract its ends within the sheath as it is wont to do when completely severed.

In all cases the thing to do is to enable the natural arrest to go on by completely dividing the vessel. In the case of an *imperfect division of a digital artery* between the fingers, the bleeding is sometimes very troublesome. In such a case the vessel should be cut down upon and carefully exposed without injury to the neighbouring nerve trunks. A ligature should be placed above and below the wound in the vessel, and then it should be divided. An Esmarch band previously applied

will make the dissection more easy ; the dressing should be put on, and the fingers tied together, before the indiarubber band is removed.

The Artery of the Frænum of the penis is sometimes ruptured during coitus. If it be torn right across, the bleeding is slight, but if only half divided it is sometimes very profuse. In this case all that is necessary is to divide it completely with a pair of scissors, and then to apply a ligature.

Wounds of the Scalp often bleed very freely, especially at first. In dressing them the hair should be cut off all round the wound, which itself should be well washed. Even if the spouting vessels are plainly to be seen, it is almost always waste of time to try and pick them up for the purpose of ligature. A good firm compress, secured with a knotted bandage, will, by ensuring pressure against the underlying bone, arrest any ordinary hæmorrhage.

Wounds of the Palmar Arch are very troublesome, and the bleeding from them is very apt to recur. This is due partly to the intimate anastomoses of the arteries, and partly to the difficulty of applying efficient pressure, the vessels themselves lying beneath, and being protected by, the thick bands of the palmar fascia.

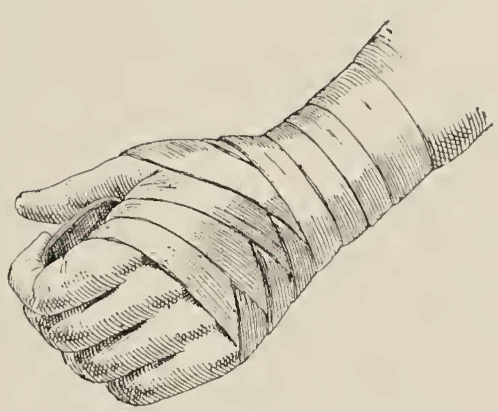


Fig. 13.—The Hand Bandaged for a Cut in the Palm.

Although it is difficult to apply pressure, in most cases it is necessary to do so, for other means would tend to cripple the mechanism of the muscles and tendons of the palm. Sometimes, no doubt, it is advisable to dissect out the bleeding vessel in this crowded region and put a ligature on it, but as a rule the hazards of this proceeding outweigh its obvious advantages. In the majority of cases the bleeding comes from the ulnar artery ; if this is secured success will follow.

In applying pressure to the palm of the hand, a firm smooth pad must be used, and the palmar fascia must be relaxed. These two conditions are well fulfilled by bending the fingers over a round piece of wood, like a ruler, covered with three or four layers of lint, or over a tight roller bandage. If this be firmly grasped, and the fingers bandaged over the cylinder, very good pressure will be made (*Fig.* 13).

But it may happen that even yet the bleeding recurs, and by this time, as several expedients have been fruitlessly adopted, the patient may be getting exhausted by loss of blood. A tourniquet or digital compression of the brachial artery can be adopted as a temporary expedient at any stage of the proceedings ; but this cannot be kept on for long, especially in this exsanguine condition of the patient.

On the whole the best plan seems to be, first of all to open up and thoroughly examine the wound, and if it appears feasible by dissection to find and tie the bleeding vessel or vessels, or failing this to tie

the brachial artery high up in the arm—a somewhat desperate remedy truly, and one which can very rarely be required if the milder measures before mentioned have been thoroughly carried out.

It should be borne in mind that the tourniquet can always be put on for an hour or two, so that the visiting surgeon can be sent for ; and also that bleeding so obstinate as this may probably be associated with a morbid condition of the blood or its vessels. (*See* 'Bleeders,' p. 38.)

In cases of hæmorrhage from sloughing wounds of the palm *no attempt must be made to apply compression.* No treatment is worse than the applieation of pressure to an inflamed and sloughing surface. Sloughing cavities are to be *lightly* packed with antiseptic gauze, but no pressure is to be exerted, or the sloughing will extend.

In these cases the wound must be opened up, and a search made for the bleeding point ; sloughs must be cut away, and the whole wound cleansed with peroxide of hydrogen. If the attempt to secure the vessel fails, the choiee will be between trying compression of the radial and ulnar arteries with flexion at the elbow, and ligaturing the brachial. When the bleeding is profuse it will be wise to perform the latter operation.

Hæmorrhage from Canalized Vessels.—Either veins or arteries may be so eonnected with the surrounding tissues that, when divided, their walls neither contract nor retract. Their mouths are thus kept open, and they are said to be *canalized.*

Thus the jugular and other veins at the base of the triangles of the neck are so bound down by the cervical fascia, that if they are divided, and especially if this occurs in the angle of a wound, they gape and bleed. This is especially dangerous in this situation, not from the hæmorrhage, but from the *danger of entry of air into the blood current* going right to the heart.

But canalized vessels may give trouble in other situations besides the root of the neck, especially at the angle of a wound held open by its gaping in tissues which are the seat of fibrous thickening or chronic inflammation, or when vessels, themselves atheromatous, are inelastic and rigid.

For vessels at the *Angle of a Wound* the best way is to extend it slightly, when they will retract. But those running through *Tissues the seat of Chronic Inflammation* are often troublesome, as in amputations for long-standing disease, when almost every vessel, insignificant though its size may be, requires a ligature, because it will not retract.

This also is the case with *Atheromatous Arteries*, but there is this additional difficulty, that because of the disease of the arterial walls a ligature is very apt to cut through them, so that great care and well-softened ligatures will be required.

Venous Bleeding.—For ordinary venous bleeding the first thing to see to is that there is nothing hindering the return of blood to the

heart, next to remember that almost all venous bleeding will cease on raising the limb, and thirdly to bear in mind that pressure will always effectually stop the flow of blood, if it be applied to *the wound itself*.

Bleeding from a Burst Varicose Vein is often one of the most furious and yet one of the most easily arrested of hæmorrhages. It is important rightly to understand it, for many lives are thrown away every year in consequence of the foolish, unreasoning conduct of would-be assistants, when this accident happens.

No one can be long in a hospital casualty department without seeing some such case as the following : A man who for a long time has had varicose veins, and subsequently a condition of chronic eczema and ulceration of the legs, stupefied by cold or drink, subjects the legs to some slight violence, so slight that very often it is hardly noticed. Presently he is aroused by the sensation of something warm trickling down the ankle, and looking down he sees his boot and stocking full of blood, which is coming from the position of the ulcer. He then becomes faint and falls. A crowd collects and (the prone position on the ground being the safest for him) he is immediately lifted and made to sit up. The bystanders then get some brandy, and proceed carefully to choke him while he is unable to swallow. Someone then sees the blood trickling along the floor or ground, and taking his handkerchief ties it tightly somewhere round the leg, which is still allowed to hang down. The patient, being then put into a cab, is driven off to the hospital, perhaps to die before he gets there, as the blood is escaping from his leg all the time.

All this might have been easily avoided by the exercise of common sense. Since the recumbent position is the best for syncope, the patient should not be raised from the ground until a suitable stretcher is provided. Then, the leg being raised a foot or so, the bleeding surface should be exposed, and any constriction round the limb on the 'heart' side removed. In all probability the bleeding will practically cease immediately the limb is raised, and a small pad and bandage being placed on the wound, it will not recur while the patient is lying down.

It should be remembered that the blood comes principally from the *proximal* end of the ruptured vein, the valves of which have been rendered incompetent by the dilatation.

If, however, the patient *must* walk soon after he has had a burst vein, the leg and foot should be firmly bandaged from the toes upwards, to a little above the bleeding point, on which there must have first been placed a pad and bandage. It is also necessary to keep the patient warm ; the loss of blood is often very great, and such patients cannot bear it well, so that it sometimes happens that after the bleeding has been stopped, they get a sudden failure of the heart's action, and die because they have been allowed to get too cold.

Hæmorrhage from Deep Wounds or Cavities.—Owing to the inaccessibility of the vessels which feed the part, digital pressure or

ligature may be impossible, and we must have recourse to pressure applied in some other way. This form of pressure is usually called '*plugging*,' and is a very important part of surgical treatment. Plugging, to be effective, must be carefully applied ; harm can only come of tying up a wound in a half-hearted way, laying on covering after covering with the idea of hiding the danger rather than of mastering it. On the other hand, a furious rush of blood, such as may come from the depths of a ruptured liver, a wounded artery, or from a torn sinus in the skull, may be controlled for a time by firm and judicious plugging of the wound, followed by pressure over it. Gauze is the material most generally employed for this purpose, and it must be carefully packed with a director or forceps into the very depths of the wound, so that pressure is exerted either on the main vessel, or at least on the actual bleeding points. Later, if necessary, as in the case of a wounded artery, measures may be taken to deal with the injured vessel by ligation. *Care must be taken that the deeper parts of the wound are plugged, as well as the superficial.* The wound when plugged requires a firm compress bandage to support it.

How long should Plugs or Pads remain Untouched?—This will largely depend upon the locality in which they are employed. In the case of the rectum it has been advised to leave the plugs untouched for a week or so. It must, however, be remembered that there is a tendency for all plugs to become impregnated with organisms after a very short time, and a plug inserted under what appear to be the most perfect surgical conditions becomes abominably offensive at the end of twenty-four or forty-eight hours. This is most undesirable ; and the tendency in modern surgery is to change the plugs in twenty-four to forty-eight hours in nearly all cases where they have been used to check hæmorrhage. In most instances the hæmorrhage will have been checked, and a light plugging can replace the first ; but should bleeding recur, it will be necessary to reinsert a firm plug, and again change it after forty-eight hours. In plugging cavities it is very essential to see that the material used goes to the very bottom of the cavity, as otherwise the hæmorrhage may continue beneath the compress, and may cause considerable destruction of the surrounding tissues. All cavities which have been treated in this way must be allowed to heal slowly by granulation.

Nose Bleeding is either idiopathic or traumatic, and is venous or capillary in character. It is of all kinds and degrees of severity, and may require for its arrest a number of expedients, some very simple, some requiring considerable skill.

But it is *often desirable not to check the bleeding* at all, as when it occurs in children in good health, and young adults of a lusty habit ; and also in some cases in young women in whom the hæmorrhage is vicarious to the menstrual flow.

Idiopathic Epistaxis may be roughly divided into two classes : the one in which it depends on simple congestion of the mucous membrane

of the nose, occurring in healthy people, and the other in which it is a strictly passive congestion, caused by cardiac or hepatic disease.

The hæmorrhage in the first class tends to stop of itself, when the congestion is removed by the bleeding ; but in the second the cause is constant, and the longer the epistaxis goes on, the more difficult it is to stop, in consequence of degenerative changes taking place in the blood. The bleeding in these cases is not a brisk flow accompanied by a good pulse and other signs of a strong circulation, but rather a feeble dribbling, sometimes stopping altogether, and then being again a little more rapid. In this way a great deal of blood may be lost by those who cannot spare it, and the bleeding, instead of being a relief, is accompanied by great depression, a feeble fluttering pulse, shallow respiration, etc.

A little experience of the aspect of sick people will enable the student to recognize those who are suffering from visceral disease, whether it be morbus cordis, or cirrhosis of the liver, or chronic Bright's disease, or a malignant growth, and to separate sharply in his own mind those in whom moderate epistaxis is rather a relief, from those in whom it is certainly an alarming symptom, and may be a source of danger. In these latter it should always be promptly checked : in the former, delay is never hurtful, and may be useful. It must be remembered that epistaxis is often caused by a new growth of the nasal fossæ or the parts around them, and a careful examination of the nares is essential in most cases, with a view both to diagnosis and treatment. In children, a foreign body, such as a pea or a piece of cinder, may be the starting-point of a mucopurulent discharge, and this is sometimes masked by a smart attack of epistaxis from the ulcerated mucous membrane.

In cases of epistaxis in children, bear in mind the possibility of a foreign body being present.

The patient should be made to sit up with the head thrown back, a towel being spread like a bib around the neck to prevent soiling of the clothes. Frequent blowing of the nose must be prevented, as this merely tends to aggravate the bleeding. If in addition to this position the venous return to the chest be promoted by loosening all the clothes round the neck, and in women by unlacing the stays, the bleeding will in most cases cease ; at the same time, if it persists, raising the arms above the head so as to lower the intrathoracic pressure will most likely prove effective. If the alæ nasi are firmly grasped between the finger and thumb and steady pressure exercised for five minutes, most nasal bleeding will cease.

The application of cold, either externally to the nape of the neck and the bridge of the nose, or internally in the form of an iced nasal douche, may be tried if the above measures fail.

Cautery.—But while all these devices have the value of being readily applied and of a domestic nature, it is unwise in any given case to persist with them when a short trial has failed. In the majority of

cases the bleeding comes from a small spot on the septum within a short distance from the anterior nares, called 'Kiesselbach's spot,' or from a hypertrophied, turgid, inferior turbinate bone. Both these points are easy of access, and it is often the simplest matter to touch the bleeding point with a cautery and stop the hæmorrhage entirely. For this purpose it is well to insert a plug of cotton-wool soaked in 10 per cent solution of cocaine and adrenalin into each nostril, and to leave it *in situ* for five minutes ; although the bleeding may continue (in some cases the application of the adrenalin is sufficient to check the hæmorrhage), the cocaine, which is a vasoconstrictor, is beneficial, and will anæsthetize the part sufficiently to enable the operator to apply the cautery without pain. The nasal speculum is now inserted into the nostril, and by means of a reflected light the bleeding point may be seen ; some small swabs of cotton-wool should be prepared to mop up the blood and so clear the field. If there are a large number of clots, the nares should be well washed out by means of a nasal douche. When the bleeding vessel is seen, the cautery at a dull red heat is pressed against it for several seconds, and if the operator has not got an electric cautery at hand, a probe heated in a spirit lamp will be quite satisfactory.

No method is at once so thorough and certain as the above, for it not only enables the operator to deal with the actual bleeding point directly, one of the first axioms in the treatment of hæmorrhage, but it enables him at the same time to inspect the anterior nares and so detect other conditions which may give rise to hæmorrhage.

Styptics.—Very little will be said on this subject, since they have nearly disappeared from modern surgery : they are messy, unpleasant, and uncertain. If for any reason the above treatment cannot be applied, then a plug of lint soaked in adrenalin chloride 1–5000 should be inserted into the nostril and pushed well back. This styptic is probably the least unpleasant of those recommended ; but its action is not as certain as that of the cautery.

Plugging.—In cases of continued failure—and they will not be numerous—we fall back on the last resource of plugging the bleeding nostril. This may be done from the front ; the method of plugging the posterior nares is unsatisfactory and unsafe.

To plug from the front, a strip of lint or gauze 18 inches long and a third to half an inch wide, and a stiff director are required. The strip must be packed right on to the bleeding point. Under no circumstances must small detached pieces be used, as they may be pushed back out of reach and cause considerable trouble ; a long end of the plug must always be left outside the nostril to facilitate its removal. This removal is facilitated by syringing at the end of twenty-four hours with some weak antiseptic, such as peroxide of hydrogen, so as to moisten the plug. It *may* be left in longer, but this is rarely advisable, since the plug frequently becomes exceedingly offensive.

Special Forms of Epistaxis.—Two forms are not very uncommon in medical practice. The first is a rather brisk attack, and comes on at a critical phase of some *Acute Fever*, such as pneumonia. In such an illness it not infrequently happens that about the sixth day an attack of epistaxis comes on, and coincidently the temperature falls, the pulse slows, and other symptoms of defervescence are manifested. This epistaxis may truly be called 'critical,' and may be compared with the profuse sweating or diarrhœa which often heralds a crisis.

The necessity for checking this bleeding will vary in each case, and no general rules can usefully be laid down. At first, at all events, it does not call for active measures. The condition of the pulse will be the best guide as to when such interference is required.

In Exhaustion.—The second form resembles the first, in that it occurs in the course of a severe illness, but in this point only, for it is a sign of a well-nigh hopeless condition. It is due to a general breaking down of capillaries, as in purpura. It is associated with bleeding from the gums, with the formation of bullæ containing blood-stained serum, and with ecchymoses. It seldom calls for any special treatment.

Bleeding from the Socket of an Extracted Tooth.—This occurs very rarely indeed to any troublesome extent, considering the enormous number of extractions performed. When it does happen, it is almost always in patients who are either in very feeble health, or who are affected with some form of the hæmorrhagic diathesis, or scurvy.

Sometimes, indeed pretty frequently, the socket of the tooth goes on bleeding for some hours, in consequence of the nutrient vessel being unusually large or unable to contract. In such a case the bleeding comes from one or two points, and it is not at all dangerous. In the really serious cases, from the whole gum and lining of the socket there appears a general welling up of blood, and this is sometimes hard to check. An 'alveolar tourniquet' has been invented for the purpose, but it is now hardly ever used, and reliance is placed on conscientious plugging and the actual cautery.

Plugging the Socket.—Lint or cotton-wool is generally used, either plain, or dipped in some styptic, such as turpentine, carbolic acid, creosote, alum, or adrenalin. In any case it must be packed away very firmly indeed, filling the whole socket, and a little more, so that the plug may be kept in proper position by the opposite tooth, if the jaws be closed with a four-tailed bandage.

A method which rarely fails was suggested by Sir A. E. Wright. It consists of filling the cavity in the gum with a mixture of formalin and gelatin. If the latter be used alone, it is soon washed away by the stream of blood, but the combination of formalin and gelatin forms a solid mass which is excellent for this purpose. Gelatin is a valuable styptic, clean and pleasant, but care must always be taken to obtain a pure sterilized specimen. This warning is a very necessary

one, since ordinary commercial gelatin often contains the spores of the *B. tetani*, and many cases have been recorded where the application of gelatin has led to the development of tetanus. It is now, however, possible to obtain without difficulty a sample of bacteriologically sterile gelatin, and this can be used without fear.

For the purpose of checking hæmorrhage from a tooth socket the procedure is as follows : Place a test-tube containing the gelatin in a bowl of water sufficiently warm to melt the gelatin. Care must be taken that the water is not too hot, for, if overheated, gelatin loses its power of solidifying when cooled. When the contents of the tube are fairly fluid, add to them $\frac{1}{20}$ part of pure formalin, i.e., if the test-tube contains 40 c.c. gelatin, add 2 c.c. formalin. Shake the tube so that the two mix. Now, with the patient's mouth wide open, sponge away the blood with gauze or wool pledgets until the socket is fairly dry, and then, soaking a thin strip of gauze in the mixture in the test-tube, press it well home to the bottom of the cavity. Keep it thus for one or two minutes, withdraw it, and pour in the mixture of gelatin and formalin, which is now nearly solid. A little care will enable the operator to fill the whole socket with this valuable styptic, which soon solidifies.

Hæmorrhage from the Rectum.—The bleeding *from Parts inside the Rectum which can be Seen, or Felt with the Finger*, may here be considered. It may be due to simple congestion of the mucous membrane, piles, fissure, prolapsus ani, the passage of some hard body, ulceration of the surface of a new growth (usually malignant), or dysentery ; or it may be the result of the division of some vessel or vessels in the course of an operation. Hæmorrhage from the rectum is often caused by lesions some distance up the bowel from the anus, and the reader is advised to familiarize himself with the various forms of rectal specula and the sigmoidoscope, which will be referred to later.

Hæmorrhage from Simple Congestion.—This occurs in consequence of the turgidity of hæmorrhoidal plexuses, which is in its turn due to obstruction of the portal circulation. The portal obstruction may take place in the liver itself, and may be due to temporary or permanent changes there, or in the lungs or heart.

As in the case of epistaxis, bleeding from this source is often a great relief to the circulation, and is sometimes imitated by the application of leeches to the anus. It hardly ever requires treatment, unless it be desirable to increase the flow, which may be done by sitting in a bath or tub of warm water. Usually the bleeding stops immediately the congestion is relieved, but if it be desirable to arrest it, an enema of thin starch, with 20 to 30 minims of laudanum in it, may be given, or an injection of cold water, or the following :—

℞ Calcium Chloride · ʒiiss | Water ℥iiiss

Inject five drachms into the rectum by means of a small syringe.

Piles must be looked upon as being due to an extension of the same

morbid processes which cause simple congestion of the mucous membrane. Only those which are covered entirely or partially with mucous membrane (internal piles) ever become so turgid with blood as to bleed. These, however, may do so very profusely, and even dangerously. The bleeding usually occurs when the patient is on the stool, and up to a certain point may relieve the portal circulation. It not infrequently, however, becomes necessary to arrest it without loss of time, for it belongs to that form of hæmorrhage which manifests itself as frequently recurring losses of blood, no one of which is of consequence, but which, collectively, are very important. *The preventive treatment must be both local and constitutional.* The bowels should not be allowed to become confined, but the motions kept pulpy by early-morning doses of the confection of senna, or the confection of sulphur, or of some saline aperient. Very careful dieting and a recumbent position are advisable, with warm light clothing, and in women the removal of stays or anything which compresses the body. Cane chairs, too, are better than upholstered ones.

Locally, the piles must be returned at once when they come down, and the opportunity may be taken to smear them over with the ointment of hamamelis (B.P.). A *Continuous Douche* of cold water from an enema syringe is very useful, as also are astringent injections of iron or alum. Another very commonly used injection is made by dissolving a drachm of alum in a pint of the decoction of oak bark, or the solution of chloride of calcium may be used.

If, on the other hand, the bleeding is important from the actual quantity which is being lost at the time, it will not be found difficult to stop. An ordinary astringent injection should be tried first. If it fails, the rectum should be cleared out by a thorough syringing of ice-cold water, and then a suitable lump or two of *Ice* may be introduced and pushed tolerably high up, the patient lying in bed lightly covered and with the buttocks raised on a pillow. This treatment hardly ever fails to arrest the bleeding, but if it should continue, recourse may be had to *Plugging.* This may be done with sponges, or with the 'petticoated plug' (as will be described directly). Again, if the patient be in a fairly good condition for operation, the hæmorrhage may be stopped and the pile cured by an operation for its removal—that one being chosen which gives the least shock.

The Mucous Membrane of the Anus when Prolapsed, partially strangulated as it is, frequently bleeds. This, however, readily stops by returning the prolapse and syringing the part well with cold water, or with alum and oak-bark lotion.

The Passage of Something Hard, or rough, or pointed, such as a cherry stone or a fish bone, is often enough not attended by any trouble until the rectum is reached, and then, in consequence apparently of the greater expulsive force employed, the mucous membrane becomes torn or scratched, and bleeding occurs. This is very frequent in children, and is easily checked by injecting a little cold water up

the rectum. Although the bleeding is of little consequence, there is good reason for holding that fish bones or splinters do sometimes, by burrowing, or being forced out of the rectum, cause fistulæ.

The ulceration of a *Growth within the Rectum* is sometimes associated with serious hæmorrhage. These tumours are usually malignant, and, in the later stages of their growth, the constant drain, by repeated bleedings, may be the immediate cause of death. The principles of treatment must be the same as for internal piles, with the addition that the effect of preparations of opium, as local applications, is often very striking.

The restraint of hæmorrhage caused by *Dysenteric Ulceration* of the rectum hardly comes within the province of this work; but inasmuch as the locality of the bleeding may be the same as that of losses of blood requiring treatment on strictly surgical lines, it is mentioned here. The loss of blood in this disease, when itself a cause of danger, is generally combated by starch enemata, to which should be added laudanum or a similar preparation of opium, or by suppositories of morphia.

Bleeding from the rectum in consequence of *the Division of Large Vessels* is extremely rare as a result of an accident; but it is common enough in the course of operations, such as those for fistulæ, internal piles, or during the larger planned operations for removal of portions of the gut.

For practical purposes the rectum may be divided into a safe and a dangerous region, so far as the use of the knife is concerned. The *safe region* is the last two and a half inches, the blood-vessels in which, though very numerous, are all of them small, being the terminal anastomosing branches of the hæmorrhoidal arteries.

The *dangerous region* is all the rectum that can be reached above the place (three inches from the anus) where the superior hæmorrhoidal branches, about six in number, pierce the muscular coat, and lie between it and the mucosa. These vessels are of a considerable size, and bleed very freely when injured.

Bleeding, then, from the lower part of the rectum, after any operation, although at first often brisk enough, speedily stops; in this situation, also, pressure can be easily applied, or, if necessary, the vessels may be tied.

But the case is very different if one of the vessels higher up in the gut has been divided, especially if the part has been the seat of inflammation which has indurated the tissues and thus causes the mouth of the vessel to be kept patent. The situation and warmth favour a rapid flow of blood, while it is very difficult to get any exposure of the part.

The hæmorrhage can always be temporarily stopped by means of the pressure of one finger; and, indeed, pressure and plugging will in most cases be the procedure resorted to in the end. Nevertheless, if it be possible to get a ligature round the vessel, a great deal of trouble will be saved. The surgeon should remember that by a free

division through the sphincters transversely across the ischiorectal space, he may safely let a flood of light upon the scene, provided, of course, that there are no internal piles or other hindrances in the way. The sphincters will readily heal, and the incision will be amply justified if by its means a ligature can be placed on the vessel.

If for any reason, after an operation for piles, when hæmorrhage is occurring, the surgeon is unable to dilate and secure the bleeding point, the rectum must be plugged. One method is to use sponges, somewhat compressed, and with a string tied round each one, or passed through them all, so as to provide for their recovery, but the best way to plug the rectum is to use a 'petticoat' (*Fig.* 14), of which the shape and object are rendered sufficiently obvious by its name. The space between the petticoat and the central stick or piece of catheter is filled with lint, or better with cotton-wool, the plug having been previously put into position in the rectum. With a large gum-elastic catheter, No. 14 to 16, and a piece of lint 12 inches square, an excellent petticoated tube can be made, if the lint is secured to the catheter by means of a stitch passing through the tube. The catheter allows the flatus to pass, and is therefore less troublesome to the patient than a bag or plug which completely blocks the bowel. Although some surgeons advise that the plug be left alone for days, we are of opinion that it should never remain longer than forty-eight hours.

Fig. 14.
PETTICOATED PLUG.

Hæmorrhage from the Genito-urinary Tract. — As might be expected, many morbid conditions of the renal tissue are associated with loss of blood. But the treatment of hæmorrhage from the kidneys or ureters is not here considered.

Hæmorrhage into the Bladder, if serious, is generally due to the presence of a new growth, enlarged prostate, or varicose veins, but a calculus or a purpuric condition may cause it, or it may be traumatic. In any case the bleeding comes distinctly under the surgeon's care and calls for active treatment. Bleeding from the prostate, again, is not uncommon, and may require to be promptly dealt with, but in the majority of cases it is simply congestive, and stops when that condition is relieved.

Generally speaking, in any of these cases, rest and relief of all congestion in the neighbouring viscera, as by clearing out the rectum, will prevent hæmorrhage into the bladder or from the prostatic vessels assuming a serious character. But if, in consequence of the vascular nature of a growth, or from some similar cause, severe hæmorrhage should occur, it will be found somewhat difficult to treat. *Locally*, ice may be applied to the perineum and hypogastrium or inserted into the rectum, or an enema of iced water may be given. The indications for *internal* treatment generally point to the employment

of such styptic drugs as turpentine, tannic acid, lead acetate and opium, ergot, or hazeline. If the bladder becomes distended with blood-clot, it may happen that the urine is retained. In this case a large catheter, such as is used in lithotrity after Bigelow's plan, should be employed. After the clots have been gently broken up with a sound or coudé catheter, the catheter should be connected with an aspirating apparatus (Clover's or Bigelow's), by means of which enough clot may be removed to allow of the passage of the urine, and with this relief the surgeon should be content.

If this treatment fails—and, in cases where the bleeding is profuse, failure is common—the bladder must be opened above the pubes and the clots turned out. The bladder cavity must then be washed out with hot water, 120° F., containing 1 oz. of extract of hamamelis to the pint. This irrigation is successful in most cases, but, if not, the bladder must be plugged. The introduction of plugging into the bladder, although a simple enough proceeding, may cause a great amount of pain, and it must only be undertaken as a last resort.

Presuming that the viscus has been opened above the pubes, it is usually sufficient to pack down strips of gauze, 30 inches long, 4 to 6 inches wide, on to the bladder base. If the bleeding comes from the prostatic region, as for instance after removal of the prostate, it may be necessary to 'tamponade' the cavity. The best method of checking hæmorrhage from the prostatic cavity after removal of the prostate is to pack the cavity firmly with a long strip of paraffin-flavine gauze—that is, gauze which is impregnated with soft paraffin and flavine—and to leave this pack *in situ* for 48–96 hours. Owing to the presence of the paraffin and the soaking action of the urine, it is readily removed by the end, which should protrude through the suprapubic wound. Rubber tampons—e.g., Pilcher's bag—which can be distended with air are much used in America, but they are apt to get out of order.

The question of the management of *Rupture of the Urethra* will be considered later. In all ordinary cases the bleeding, although it may be rather free at first, is easily arrested by rest, and cold to the perineum. But a very furious bleeding into the urethra may occur in consequence of *Rupture of the Bulb* or corpus spongiosum from external violence ; in these cases the blood pours from the erectile tissue and escapes from the meatus urinarius at a rate which will quickly exhaust the patient unless it be arrested. Pressure is the only means of arrest, but pressure here is very difficult to make effectually ; the best way is to pass a full-sized gum-elastic catheter and to make compression in the perineum upon it, at first digitally and later by pad and bandage.

Bleeding from Granulations occurs when they are injured, even if absolutely healthy, and may then readily be stopped by pressure. But if the granulations spring from the base of a hæmorrhagic ulcer, or occur in wounds or sores of patients who are extremely

feeble, or who are scorbutic, the hæmorrhage sometimes is difficult to arrest. In these cases, as in others, the sheet anchor of treatment must be pressure, but much may be done by constitutional treatment* and stimulating lotions, such as Lotio Arg. Nitratis gr. v–x to ℥j of water, Lotio Zinci Sulph. gr. iv to ℥j of water, etc.

A treatment which is very frequently successful is to *scrape the granulations* completely away with the edge of a scalpel, or with a 'Volkmann's spoon,' such as is used for the eradication of lupus. Another good plan is to apply Martin's or Esmarch's indiarubber roller, without the strangulating cord, to the whole limb, including the bleeding sore, for not more than twenty-four hours. Or, finally, recourse may be had to cauterization with fuming nitric acid, or with the actual cautery.

Hæmorrhage from Sloughing Phagedæna.—That extremely rapid form of destructive inflammation known as *Sloughing Phagedæna* or *Hospital Gangrene* must be mentioned here only as being sometimes a cause of hæmorrhage. The disease is peculiar, inasmuch as in the manner of its invasion of the tissues it resembles the course of a malignant ulceration, and does not spare the blood-vessels, but, affecting their coats, may cause the most furious bleeding. It is, however, so rare since the introduction of the antiseptic or aseptic treatment of wounds, that it is probable a surgeon may never see a case during his career as a student or in after-practice.

Vessels may, of course, frequently be destroyed by ulceration without bleeding, from previous obliteration of their lumina. It is therefore in the most rapid forms only of this disease that bleeding takes place ; this is also true of a hæmorrhage from a somewhat similar cause, namely, that which is due to the destruction of large vessels by the formation of abscesses in dangerous regions. In such cases bleeding would be far more frequent but for the fact that time is given for the plugging of the vessels. It does, however, occur.

When, therefore, in a case of hospital gangrene, the disease invades the neighbourhood of a large vessel (e.g., in sloughing phagedæna of the groin), the greatest watchfulness must be exercised, and some form of tourniquet be ready to be applied instantly if the vessel gives way, so that time may be gained to send for assistance.

It is often very hard to decide upon the best means to adopt for the permanent arrest of this form of bleeding. If the vessel be small the thermo-cautery or nitric acid may be sufficient, but if it be a main trunk it must be ligatured, and in that case the surgeon will have to choose between the difficulties of securing a vessel itself diseased in the midst of sloughing tissues, and the risks of securing the trunk higher up by a separate operation.

Hæmorrhage from Malignant Growths.—Like sloughing phagedæna, most malignant tumours do not spare the vessels in the tissues

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* *See* 'Bleeders,' p. 38.

among which they spread, and one of the most frequent causes of death in these cases is hæmorrhage from a vessel which is involved in the course of malignant ulceration. This would be more frequent still, were it not that the vessels are so often previously obliterated. The arrest in these cases, and the precautions to be taken, are precisely those which have been mentioned for phagedæna, with the simple exception that it will never be right to attempt to put a ligature on the vessel at the seat of hæmorrhage, that is, in the substance of a malignant growth. But in addition to this form of bleeding by invasion of vessels, malignant tumours are generally very highly vascular, and in the later stages of their growth break down, and then their ulcerated surfaces are apt to bleed, sometimes very profusely, as may readily be imagined, since the blood-supply of some of the softer sarcomata is abundant enough to cause the whole mass to pulsate.

A variety of methods may be adopted for the arrest of this form of bleeding. Moderately firm pressure, cold, as by applications of ice or the ether spray, the use of styptics such as adrenalin chloride, alcoholic solutions of hamamelis, or gelatin and formalin : all or any of these may in different cases be found efficient. In certain cases, ligature of the main vessel of supply is indicated, as of the lingual artery in some cases of epithelioma of the tongue ; but the actual cautery will hardly ever be advisable.

When the ulcerated surface of a malignant growth is apt to bleed, a good application is a powder of equal parts of crude opium and cinchona bark, which must be dusted on the part, though there is no more satisfactory application to the surface of a malignant tumour which is fungating than a 5 per cent solution of cocaine, followed by the preparation of formalin and gelatin described above (p. 25).

Hæmorrhage from an Aneurysm.—Occasionally, but very rarely, an aneurysm ruptures externally, and causes violent bleeding, and there are even one or two cases on record in which the occurrence has resulted in the cure of the disease. It is not within the scope of this work to discuss the surgical proceedings which should be taken for the permanent arrest of this bleeding, but we must consider the measures for stopping it at first.

Contrary to what one would expect in such cases, the giving way of the tumour occurs insidiously ; the aneurysm *leaks* rather than bursts (we are speaking of those on the external surface of the body) ; the skin becomes irregularly ulcerated over it, and the first appearance is rather that of an abscess or a superficial bleeding sore. The bleeding, too, is intermittent and, at first, apparently not serious. The loss, however, at each attack becomes greater and greater, and soon there is a general yielding of the skin, which is now all that restrains the flow, and a gush of blood, which may be immediately fatal, takes place.

Treatment.—What should be done in the first instance ? We will take as an example an aneurysm of the superficial femoral, say, in

Hunter's canal. If the condition be that of a slight intermittent oozing from one or two apparently superficial ulcers, in the reddened unhealthy skin lying over the pulsating tumour, the leg should be raised and carefully bandaged from the foot upwards. A Martin's indiarubber bandage is best, and this should be carried somewhat more firmly over the tumour, a folded piece of lint being placed between the skin and the bandage. Some form of tourniquet, e.g., Esmarch's indiarubber cord (*Fig.* 4), should then be adjusted so that it can be tightened up in an instant if required. This being done, there is little immediate danger, and time will be given to the visiting surgeon to determine whether he will turn out the contents of the aneurysm after opening it freely, and then proceed to ligature both ends of the vessel; whether he will pass a ligature round the femoral or external iliac artery; or whether he will adopt any other proceedings for the permanent cure of the disease.

But supposing the case has been allowed to drift on, until there comes a furious gush of blood from a considerable yielding of the skin and sac? There will be no time for deliberate bandaging, but a finger must at once be placed on the main artery (in this case the common femoral) and retained there until replaced by a tourniquet. The bleeding cavity must then be packed most carefully and firmly with gauze or strips of lint, until it is absolutely full, and then pressure made on it from above with a firm ordinary bandage, or an indiarubber one, over a pad. Finally, it may be necessary, in some situations, to put the finger into the cavity which is bleeding, to feel for the place whence the rush of blood proceeds, and to arrest it by keeping the finger on the spot till help arrives.

The wound once effectually plugged and compressed, the tourniquet may be gradually slackened, and if the bleeding does not recommence, should be left loose, but in position: the further treatment must be left in the hands of the visiting surgeon.

We have been particular in describing the temporary arrest of this form of hæmorrhage, although it is rare, because it serves as an example that *a man should never be allowed to bleed to death from any external hæmorrhage*, inasmuch as it may always be arrested, first with the finger placed on the bleeding point, or on the main artery, and then by plugging and pressure.

Hæmatemesis.—Although, generally speaking, hæmatemesis, or bleeding from the stomach, is regarded more as a medical than a surgical affliction, a surgeon is often called upon to treat this condition. It may be at once acknowledged that actual operative interference for the hæmorrhage while it is continuing is rarely called for, and rarely successful when practised, though the occurrence of *repeated* hæmorrhages renders surgical intervention imperative in the interval between the bleedings.

In a given case of hæmatemesis, when the bleeding is fairly profuse, the patient must be put to bed and a full dose ($\frac{1}{4}$ gr.) of morphia

administered hypodermically ; *no food must be given by the mouth* ; an ice-bag should be placed over the epigastric region.

Hæmostatic drugs—ergot and tannic acid—*should not be administered.* Adrenalin and chloride of calcium have not been very successful, but gelatin, as in other cases of bleeding, has been of great service. A jelly is made as follows :—

Gelatin	℥j	Syrup of Lemons	℥j
Sugar	℥j	Water	℥vj

℥ij o. h.

It should be given with ice, and is very pleasant to take. The above treatment is usually efficient ; but it is necessary in some cases to use whole blood transfusion. The details of this method of treatment are to be found in Chapter IV. It is sufficient here to say that in all cases of severe loss of blood admitted to hospital, the patient's blood should be grouped and arrangements made to obtain the services of a suitable donor, so that, in the event of the hæmoglobin falling below 60 per cent, no delay will occur if transfusion is decided upon. During the attack, and for some days subsequently, the patient must be fed by nutrient enemata, and mouth feeding must be restarted with the greatest possible care.

Hæmoptysis, or bleeding from the lung, the blood being coughed up, and not vomited as in the preceding variety, also comes under the notice of the surgeon in connection with injuries to the thorax.

Active operative interference may be required where, in addition to the injury to the lung, there is free bleeding into the pleural cavities ; but this will be considered later. In the meantime, for the actual hæmoptysis it is always advisable to get the patient to bed (on to the injured side if possible, so as to allow the uninjured lung to work freely), to administer $\frac{1}{4}$ grain of morphia, and to apply a large ice-bag over the damaged area. As there is no interference with the stomach, ergot ($\frac{1}{2}$ dr. of the liquid extract) can be given every four hours.

Secondary Hæmorrhage.—A bleeding is called *Secondary* when it comes on at some period subsequent to the division or injury of the vessels maimed either by an accident or in the course of an operation. It is divided into *Recurrent* and *True Secondary Hæmorrhage.*

Recurrent or *Reactionary Hæmorrhage* is that form which comes on as soon as the period of lowered cardiac action and partial collapse which is occasioned by the shock of an operation, or of an accident, passes off, i.e., within four or five hours of the injury. By this time, too, the contraction occasioned by the exposure and division of the vessels has largely passed away. There is then present a condition of increased cardiac activity and relaxed vascular walls, so that it is not surprising that very frequently there is free general oozing from a wound which, at the time it was done up, appeared quite dry. The bleeding is chiefly capillary, or proceeds from small arterioles, which had been so firmly contracted as not to declare their presence at the former examination. Larger trunks which have not been tied

firmly enough (which should never occur), may burst their bonds and bleed freely.

Treatment.—Much will depend upon the discretion and common sense of the house surgeon in these cases. While it is a most serious error to overlook a case of active reactionary hæmorrhage, it is at the same time needlessly distressing for a patient to have a painful wound opened up—often in the middle of the night—for a slight oozing which pressure would have checked. The house surgeon must be guided by the nature of the operation performed, i.e., whether large vessels have been divided, as in the case of an amputation, and by the condition of the dressings, whether the 'coming through' of the dressing is due to serum and a little blood, or a quantity of blood and a little serum. In this connection he may remember that with a fairly large dressing, a serous exudation is more likely to appear at the end of the stump in cases of amputation, and forms a yellowish-green zone several inches wide round a red centre, whereas in hæmorrhage proper the blood will be found at the most dependent part of the dressings—that is, in a case of amputation of the lower extremity, on the under aspect of the stump, trickling towards the buttock, and the surrounding stain of the serum will be faintly marked. Lastly, he must be guided by the condition of the patient. If the pulse is good and full, and there is no feeling of faintness, he may, in conjunction with the considerations given above, rightly decide to pack the wound and wait. To pack a wound under these circumstances, the outside bandage should invariably be removed. It has been in contact with the bedclothes and other materials which are not sterile, and to bury it under a large pad of wool is most unwise. When the bandage has been removed, a large pad or pads of wood wool should be placed on the top of the original dressing and the whole region *firmly* bandaged. If this be properly done, and if the house surgeon has been right in his selection of the case for the application of this treatment, there will be no more trouble.

But, on the other hand, where he suspects that there is serious bleeding, or perhaps where he has had recourse to packing and it has failed, what is to be the next step? All preparations must be made to open up the wound, and these preparations must be undertaken as carefully and as methodically as for the original operation. Too often the carelessness of hurry in the anxiety of the moment causes grave omissions in our technique of asepsis. An anæsthetic is to be administered, either in the ward or the theatre, wherever the operation is to be performed, and we would insist most strongly on this point. If the house surgeon has decided that packing is out of the question in a given case, then he must be prepared to go to all extremes to check the hæmorrhage which is occurring, and nothing is more unsatisfactory and distressing than to see a house surgeon endeavouring, with insufficient light, to secure a vessel in a struggling, shrieking patient. The first object is undoubtedly to check the hæmorrhage, but unless

there is some good reason to the contrary an anæsthetic should be given.

Then, without hurry or the infliction of pain, the wound is opened up, irrigated with hot saline, 120° F., and a search made for the bleeding points ; no difficulty will arise provided proper preparation has been made. They must be secured with ligatures, the wound cleared of clot, and the edges brought together again. If a large amount of blood has been lost, it will be necessary to inject some saline solution into the tissues or the vein, or to transfuse the patient (*see* p. 43).

After reactionary hæmorrhage has once occurred, the patient should be carefully watched.

True Secondary Hæmorrhage rarely occurs earlier than a week or ten days after the injury or operation, and its cause is usually some ulcerative or sloughing condition of the walls of the larger vessels. Thus, it may come from an artery which has been ligatured in its continuity, in consequence of the coats near the ligature being unhealthy ; or it may come from a lacerated wound at the time of separation of the sloughs, or from ulceration of a vessel ligatured in the flaps of an amputation wound.

The single exception to this form of hæmorrhage proceeding from a morbid inflammatory process is in those cases in which an animal ligature has become absorbed too quickly (a rare occurrence with the well-prepared catgut at present in use), or a silk one has cut the coats or come untied, so that the arterial coats, weakened by the tying, will then give way.

A form of hæmorrhage which may be classed under this heading, since the treatment is similar, is that resulting from ulceration of a large vessel either from the destructive process of phagedæna or from the proximity of an abscess.

Secondary hæmorrhage is very serious. It constitutes a most formidable complication, and in considering the means for its arrest, questions of amputation, re-amputation, or ligature of main vessels have to be weighed by the visiting surgeon ; but for us the subject is narrowed to the best ways for its immediate arrest.

It has been customary to look upon secondary hæmorrhage as occurring in two varieties : (1) *With warning* ; (2) *Without warning.* In the first type a little dribbling will be noticed when the wound is dressed, about the ninth or tenth day after the operation. The wound will have become sloughy and septic, and there will have been considerable destruction of the tissues. No time must be lost in putting a tourniquet round the limb and preparing for further treatment, and it may be taken as an axiom *that when arterial bleeding occurs, independently of probing, under the above conditions, all measures for the treatment of secondary hæmorrhage must be taken.* Unfortunately this warning is occasionally neglected, and the trifling hæmorrhage regarded as of no importance, until a sudden violent

gush of blood depletes the patient and possibly determines a fatal issue.

Whether the amount of blood lost in cases of secondary hæmorrhage is large or small, steps must be taken to bring about its immediate arrest.

Treatment.—If the hæmorrhage be from an *Artery Ligatured in its Continuity*, the steps which ought to be taken immediately, and which may suffice in some cases for its permanent arrest, are precisely the same as in the case of an aneurysm which has undergone external rupture, and to these the reader is referred (*see* p. 32).

If hæmorrhage occurs from *an Amputation Stump*, it must be arrested in the first instance by elevation, and compression of the main artery by the fingers or a tourniquet. The means to be adopted for the permanent arrest will depend on the condition of the stump ; whenever practicable, the most satisfactory proceeding is to open up the flaps and tie the artery. A little blunt dissection will nearly always permit of its being seized with forceps and drawn down so that a ligature can be applied to a portion of the vessel that is healthy. It is better to use a stout ligature, and on the whole catgut seems the best material. If this is not possible from the sloughing condition of the parts, then the choice will lie between re-amputation and ligature of the trunk-vessel higher up.

If the hæmorrhage proceeds from *Extensive Sloughing* of a lacerated wound, it takes place about the time of the separation of the sloughs ; in dressing bruised wounds, therefore, great care should be taken about the tenth day not to tear the sloughs away before the vessels have become occluded by natural processes. The bleeding is generally arrested by plugging and compression, but any vessel that will hold a ligature should be tied. The actual cautery may be used with good effect, but styptics, especially perchloride of iron, should be avoided.

Secondary hæmorrhage was for many decades of rare occurrence ; the house surgeon met with it but occasionally—as, for example, from the lingual artery after removal of the tongue, when the bleeding could be checked by pressure of a gauze strip, or by catching the vessel and tying it. Unhappily the late war altered this ; serious secondary hæmorrhage from the septic wounds was all too common. The above general principles, however, remain applicable, and recent experience has confirmed the teaching of our predecessors, that in all cases of secondary hæmorrhage it is far wiser when possible to tie the actual bleeding point—proximally and *distally* if the artery be damaged in continuity—than to rely on proximal ligation of the main vessel—a method of treatment which is eminently unsatisfactory. In many cases of secondary hæmorrhage the question of amputation has to be considered, and it is far wiser—if an honest attempt to check the bleeding has failed—to have recourse to amputation rather than let the patient run the risk of losing his life from bleeding.

In cases of secondary hæmorrhage when sepsis is present, the wound

is to be freely opened, and well washed with peroxide of hydrogen, Dakin's solution, or flavine (*see* Chapter XXIII).

'Bleeders.'—Reference has been made in several places to the constitutional conditions known as the '*Hæmorrhagic Diathesis,*' or *Hæmophilia*, and those possessing this diathesis are generally called 'bleeders.' It is in a very marked degree hereditary, and is transmitted by both the male and the female sides, but it affects males far more frequently, the most common transmission observed being through the females, who do not suffer, to their sons.

'Bleeders' manifest their idiosyncrasy either by spontaneous hæmorrhages from such parts as the gums and palate, the rectum, or the bladder ; or by persistent bleeding from some wound, large or small ; or by the effusion of blood or blood and serum into the synovial and serous cavities or subcutaneous tissues.

In the case of wounds the importance of the case only gradually develops ; there is no furious gush of blood, but a general 'weeping' of the whole surface, which looks as if it only required a little time to stop of itself ; but at the end of twenty-four hours the position of affairs is precisely the same, with the exception that the loss of blood, continuous as it has been, has caused a distinct constitutional effect, while very probably the pressure employed in futile attempts to check the drain has produced sloughing of the edges of the wound and hence an enlargement of the bleeding surface. And so matters go on. The blood, natural in its appearance at first, becomes thin and watery, while the patient is exhausted to the last degree, and seems likely to die, it may be from such a trivial injury as an extracted tooth or a cut finger. Death may occur, but occasionally, just when the case looks most hopeless, the wound takes on a healthy action, the bleeding ceases, and the patient begins to repair the enormous drain on his resources.

The chief change in the blood seems to be a deficiency of fibrinogen, and the danger can be gathered from the statistics of Litten, who found that 60 per cent of the patients die before the age of eight, while only 12 per cent live to twenty-two and over.

Treatment.—In considering the best means of checking the bleeding, constitutional as well as local remedies must be thought of ; hence it is important to find out, in any case of unusually prolonged bleeding, whether the patient be a genuine bleeder or not. Inquiry will generally elicit a history either of a previous injury in which the bleeding "seemed as if it would never stop," or of a father, brother, or uncle who had shown similar characteristics.

Local Treatment.—The character of the bleeding puts the idea of trying to ligature any of the bleeding vessels out of the question, and a little reflection makes it plain that the ligation of a trunk-vessel will only substitute two bleeding wounds for one.

Compression should be applied to the bleeding area with either 1–5000 adrenalin solution or the formalin and gelatin mixture in

addition. In some cases the actual cautery may be tried. The local effects of subcutaneous injection of ergotine are sufficiently marked to indicate its employment.

Constitutional Treatment.—Absolute rest should be imposed on the patient, and 1 dr. daily of chloride of calcium should be ordered. Reverdin recommended sulphate of soda (2 gr. every two hours). A prolonged use of dried extract of pig's liver and chloride of calcium is the best preventive treatment.

According to Wright, the inhalation of CO_2 for a few seconds, which increases the venosity of the blood, will always check the bleeding in hæmophilia. The administration of horse serum—preferably by hypodermic injections—is now recognized as of great value in the treatment of 'bleeders.' Serum so employed appears to hasten the coagulability of the blood ; 10 to 15 c.c. should be injected. If in a case of emergency it is difficult to obtain horse serum, human serum obtained from a blister, or even antidiphtheritic serum, has been used with success.

Blood transfusion, apart from its value in replacing the blood lost, is of great assistance in checking the actual hæmorrhage.

Perchloride of iron is more useful in the later stages, while for a dangerous anæmia produced by the bleeding, if this has been checked, the injection of saline solution into the rectum may be advisable.

The action of *Opium* in quieting and regulating the circulation gives it great therapeutic value as an indirect hæmostatic in this form of bleeding, when the heart's action becomes feeble and the pulse empty and jerky.

From our account of the diathesis it must not be supposed that every injury to a hæmophiliac is necessarily followed by extreme consequences, nor, on the other hand, that every case of troublesome capillary bleeding stamps the patient as an example of the condition. There are borderland cases, and also cases which simulate the diathesis, either through simple flabbiness and laxity of the vascular walls, or from the presence of some other constitutional vice, such as leucocythæmia or scurvy, or the condition known as 'scurvy-rickets.'

CHAPTER IV

OF SOME PRINCIPAL FORMS OF INTERNAL HÆMORRHAGE, AND OF THEIR ARREST, AND OF TRANSFUSION

INTERNAL HÆMORRHAGE.

THE important points to be attended to in promoting the arrest of *Internal Hæmorrhage* may here be briefly considered, those cases only being taken into account in which the loss of blood is sudden and is the prominent symptom at the moment, whether the cause of the loss be a traumatic or a constitutional one.

Thus apoplexy will be considered under another heading, while for chronic hæmoptysis, renal hæmaturia, etc., the reader is referred to works on the practice of medicine.

Whenever a large quantity of blood escapes from the blood-vessels, whether it flows away from the body, or into one of its cavities, the prominent symptoms are those of cerebral anæmia. There is a sudden feeling of nausea and giddiness, with a buzzing in the ears, then the sight goes, and the patient falls to the ground and becomes insensible. In such a case there is sometimes a superficial resemblance to an epileptiform or apoplectic seizure, but as a rule the extreme pallor and the fluttering pulse, which is often nearly extinguished at the wrist, will be sufficient indications of what has happened.

The recognition and treatment of cases of internal hæmorrhage are the most difficult problems that the house surgeon has to face ; and it may be said at once that although on paper we are able to draw many distinctions between this condition and that of shock, it must be borne in mind that these states are often present together, and absolute reliance on any single symptom is most fallacious. In coming to a conclusion the whole aspect of the case is to be considered.

What is the kind of case the house surgeon has to treat ? A man has been crushed between the buffers of a train, or has been run over by a heavy dray ; he is brought into the hospital profoundly shocked as the result of damage to his solar plexus. He has probably sustained a fracture or two, and he may have received an injury which has ruptured his intestine. We are here considering only the results of hæmorrhage, which may take place into the pleural or peritoneal cavity, or into the cellular tissues of the loin after injury to the kidney. It is obvious that the house surgeon has a very difficult case before him. An operation performed in the presence of shock is bad surgery.

The patient must be taken to the ward, put to bed with the head low,

and hot bottles placed all round the body and limbs, and a careful systematic examination made of the three regions indicated above, with as little exposure as possible.

Examination of the thorax may reveal broken ribs, surgical emphysema, and dullness, denoting blood in the pleura with or without pneumothorax. If this appears to be the only region injured, the patient should be placed on his back, or on the affected side, so as to leave the uninjured lung free to expand. Ice-bags should be placed over the injured spot as soon as the initial shock is passing away. As a rule, no operative interference is called for unless the collection of blood and air is of such a size as to embarrass the uninjured organ, when the thoracic cavity should be aspirated with all aseptic precautions.

The abdominal cases are the most difficult. Here the shock is profound. How are we to say whether hæmorrhage is taking place into the peritoneal cavity or not? In hæmorrhage alone the pulse has often a large wave with no tension: the so-called *hæmorrhagic pulse*; in shock it is usually small and feeble. Unfortunately the combination of shock and hæmorrhage gives us a weak, feeble, often rapid pulse, of no diagnostic value. In both conditions the patient is cold, the skin surface and the mucous membranes are blanched, and the pupils may be dilated. The respirations in shock are usually shallow or effortless; but in hæmorrhage they are peculiar: there is a distinct gasp or catching for air, owing to the amount of blood available being insufficient for the oxygenation of the tissues. This 'air hunger' is a point of importance. In hæmorrhage also there is usually marked restlessness, and consciousness is present, though the patient complains of a feeling of faintness, dizziness, spots floating before the eyes, and may suffer from convulsive attacks due to the anæmia of the brain. These form some of the distinguishing features of internal hæmorrhage.

We must admit that most of these only appear in the later stages when a fatal issue is imminent, and therefore in many cases of abdominal injury it is not possible to say at once whether there is or is not evidence of internal hæmorrhage *until the case has been watched.*

We have now reached the crucial point of our investigations. The patient must be watched with the utmost care—and the greatest responsibility rests with the watcher, since he is often the only one in a position really to decide whether hæmorrhage is occurring. *Under no circumstances, therefore, must stimulants be given or transfusion resorted to unless the condition is so serious as to permit of no delay;* both are most injurious if hæmorrhage is occurring, since they will tend to increase it; both are misleading, since they may cause a temporary improvement which is entirely deceptive. *If, after the patient has been put to bed, well covered up, and warmed by hot-water bottles, with the head kept low, there is no improvement or even a change for the*

worse, as shown by increasing rapidity of the pulse and failing volume, it is practically certain that hæmorrhage is going on ; the abdomen should be bandaged firmly, the visiting surgeon summoned, and all preparations made for performing abdominal section.

As soon as the diagnosis has been made, and all is in readiness for the operation, blood transfusion can be employed if required.

Lastly, a word on the examination of the abdomen. Hæmorrhage occurring into the peritoneal cavity may give rise to a shifting dullness in the flanks, i.e., a line of dullness which varies with the position of the patient, and, if present, this is of some value in determining the diagnosis ; but it is just one of those signs which, if relied on too implicitly, will bring one to grief. The peritoneal cavity may be swamped with blood, but the percussion note may be resonant all over the abdomen, while a loaded movable colon may give some of the physical signs of free fluid.

If the hæmorrhage is occurring from an injured kidney, the blood may be effused into the loin or into the peritoneum.

After the abdomen has been carefully examined, the urine must be withdrawn by a catheter as a routine to show whether, from renal injury, blood is being passed down the ureter into the bladder.

Such, then, is an example of cases frequently encountered. The timely recognition, by careful examination, of internal hæmorrhage may result in the saving of the patient's life ; delay may sacrifice it. Hasty operations in patients profoundly collapsed will be followed by disaster. Although the responsibility of the final decision as to an operation rests with the visiting surgeon, this decision will be greatly assisted by a careful report of the progress of the case while under the house surgeon's observation.

Immediate Treatment.—The immediate treatment of severe internal hæmorrhage, apart from operative measures, is sufficiently simple. It may be summarized thus :—

(1) To prevent further loss of blood ; (2) To keep the circulation quiet ; (3) To keep up the blood supply of the nerve centres in the brain for circulation and respiration.

1. *Measures for Preventing Further Loss* will vary in different cases, but the chief ones are—absolute rest, local application of cold, and lowering the functional activity of the organs affected as much as possible. Thus, if the bleeding be from the lungs, the patient should be kept lying flat, with very light and loose clothing ; be made to suck ice, and enjoined not to speak. In this way the lungs are placed at rest as far as it is possible for them to be.

2. *To Keep the Circulation Quiet.*—The absolute rest will greatly help this, but the administration of half a grain of morphia will be found of great value.

3. *To Maintain the Blood Supply to the Brain.*—The fulfilment of the third indication—the blood supply of the respiratory and cardiac nerve centres—is best attained by lying flat. We all know that this

is the best position for syncope, because then the feeble heart can most readily drive out its scant supply of blood to the brain. Lowering the patient's head when breathing stops during the administration of chloroform is only an extension of the same principle.

But in *Very Severe Hæmorrhage*, position alone may be insufficient, and we may see the syncope getting nearer and nearer to death, from the bloodless condition of the base of the brain. In the first place, all the blood that is in the body should be utilized for the purpose of brain supply. To do this effectually, the head must be lowered and the pelvis raised ; the arms held so that the veins tend to empty themselves into the heart ; while the legs should be raised, and bandaged from below upwards—an elastic bandage (Martin's) is best—so as to squeeze all the blood out of them as far as possible. All these proceedings are sometimes called 'autotransfusion.'

Artificial Respiration.—In extreme syncope from bleeding, as from any other cause, the surgeon must be prepared for complete failure of the breathing, and must be ready to begin artificial respiration (q.v.) whenever he sees the movements of the chest becoming suspiciously shallow.

Transfusion.—But further, there can be no doubt that, rather than allow a patient to die from want of blood, the deficit ought to be supplied from elsewhere. This may take the form either of transfusion of blood or of saline solution.

BLOOD TRANSFUSION.

By T. Joekes, M.B., M.R.C.S.

The Matching of Bloods for Transfusion.

If a transfusion of blood is contemplated, the first important thing is the choice of a suitable donor, who must not only be healthy and preferably between the ages of, say, 18 and 30, but must also belong to a suitable 'group' as regards his blood. Landsteiner in 1901 detected the presence of iso-agglutinins and iso-hæmolysins in the serum of normal, healthy individuals, i.e., he discovered that the serum of some persons is capable of agglutinating and hæmolysing the red blood-corpuscles of other persons. In 1907 Janskìj found that all human beings can be classified in four distinct 'blood groups,' according to the presence or absence in their blood of these agglutinins, and this has since been repeated and confirmed by many others.

As it has now been well established that the untoward results which sometimes follow transfusions of blood are in the great majority of cases due to hæmolysis or agglutination of the red blood-cells of either the donor's or recipient's blood, or both, it is of the greatest importance to ascertain whether the blood of any individual is suitable in this respect for transfusion into the vein of a given patient. This can be done by a very simple test, and, since hæmolysis does not occur

without agglutination, it is sufficient in practice to test for agglutination only.

To explain this grouping it is necessary to assume the existence of two distinct agglutinins, which may be present alone or in combination, or may both be absent. According to Moss's classification, persons may be grouped as follows :—

Corpuscles of a person belonging to	Are agglutinated by sera of
Group I	Groups II, III, and IV
Group II	Groups III and IV
Group III	Groups II and IV
Group IV	No other group

On the other hand :—

Serum of	Agglutinates corpuscles of
Group I	No other group
Group II	Groups I and III
Group III	Groups I and II
Group IV	Groups I, II, and III

This may be represented more graphically by a third table :—

SERUM

Corpuscles	Group	I	II	III	IV
	I	—	+	+	+
	II	—	—	+	+
	III	—	+	—	+
	IV	—	—	—	—

+ Agglutination. — No agglutination.

From this table it can be seen at a glance that it suffices to have a stock of Serum II and Serum III to be able to group anybody's blood. Such sera, if kept sterile and stored in a cool, dark place, will remain active for months. The ordinary clinical method now commonly used is as follows :—

A single good-sized drop of the Sera II and III are placed side by side on an ordinary glass slide and marked II and III. The lobe of the ear or a finger of the person to be tested is well cleaned with ether and pricked with a sterile needle in the manner commonly used when taking blood for a blood-count. A small quantity of the blood which now exudes is taken up at the end of a small blunt glass rod and thoroughly mixed with the drop of Serum II. The same process is repeated with the Serum III, using a different glass rod or the same

one after having it carefully wiped clean, so as to prevent any mixing of the Sera II and III.

Enough blood should be taken to impart a very definite red tint to the mixture ; too much or too little may interfere with the reaction. The slide is then gently rocked to and fro so as to keep the corpuscles well mixed in the serum, and at the same time the drops are closely watched in a good light and against a white background. In the case of a positive reaction the drop presents, within a minute or two, a coarsely granular appearance which is quite unmistakable. The only important source of error is rouleau formation, which not infrequently happens. In this case the clumps are as a rule very small, and under the microscope the corpuscles can be seen to lie in rows within the clumps. Re-mixing of the cells with the aid of the glass rod tends to break up the rouleaux and to favour agglutination. In this way any prospective donor can be 'grouped' within a few minutes, and preferably an individual belonging to the same group as the patient should be chosen. If such a person is not available at the moment, a donor from another group can be used, *provided the serum of the patient does not agglutinate the corpuscles of the donor.*

Thus, recapitulating, patients of :—

Group I, having no agglutinins at all, can receive blood from any group, and are known as the *universal recipients.*

Group II	may be	transfused	with blood	from	*Group*	*II* or *IV*.
Group III	,,	,,	,,	,,	,,	*III* or *IV*.
Group IV	,,	,,	,,	,,	,,	*IV* only.

This table shows that patients belonging to any group can receive blood from a *Group IV* person, and this is therefore known as the *universal donor group.*

Although this simple method of grouping is quite sufficient and reliable in the great majority of cases, two possible sources of error should be pointed out here :—

1. Occasionally the serum of a patient, whose corpuscles give the normal reactions of one of the four groups, is found to possess agglutinins for the corpuscles of all the four groups, even of *Group IV*. In my own experience it has happened twice that I was asked to perform a transfusion on patients with anæmia of the pernicious type, one belonging to *Group II*, the other to *Group IV* ; the sera of both these patients instantly and strongly agglutinated the corpuscles of even *Group IV* donors, so that a transfusion was clearly contra-indicated. This emphasizes the advisability of testing the donor's blood against the patient's serum at once if time permits.

2. In patients who require repeated transfusions, any of the later transfusions of the series may give rise to serious symptoms whether or not the blood is taken from the same donor who had been used without any ill effects on the previous occasions. As in some of these cases the most elaborate tests fail to indicate the presence in the

patient's serum of any agglutinins against the corpuscles of the donor, such reactions are probably of an anaphylactic nature. Bearing this possibility in mind, one should always inject the blood very slowly when performing a transfusion on a patient who has been transfused before, so that the procedure may be stopped at the first sign of reaction.

In both these categories of patients the very simple method of Waag, i.e., giving repeated subcutaneous injections of small doses (5 c.c.) of blood, should be given a thorough trial, as this method is entirely free from any serious complications and very striking results have been claimed by the author. No grouping is required for this method.

Method of Blood Transfusion.

The methods which have been employed may be classified as follows :—

1. **Direct Method.**—This consists of making an anastomosis between an artery of the donor and a vein of the recipient, either directly by end-to-end anastomosis or with the aid of a cannula. This method has almost entirely been abandoned for the following reasons : (*a*) It requires great technical skill, which renders it unsuitable for general use ; (*b*) The artery of the donor is permanently damaged ; (*c*) The impossibility of determining the amount of blood which passes from donor to recipient ; (*d*) The very great risk of infection for the donor when giving his blood to a patient with septicæmia.

2. **Indirect Method.**—Here the blood of the donor is collected in a receiver—syringe or flask—and then injected into the patient's vein, and the blood may or may not be mixed with an anti-coagulant to prevent clotting.

a. Without the Admixture of an Anti-coagulant.—These transfusions are commonly known as the whole-blood transfusions ; there are two methods of giving whole blood :—

i. The syringe method, popularized by Lindeman, which requires two skilled operators, at least one or two assistants, and a minimum of four syringes of 20 to 25 c.c. capacity. Using a wide-bore needle with rubber connection, the first operator fills a syringe with blood from the donor, and, disconnecting the syringe from the rubber connection so as to leave the needle *in situ*, hands the filled syringe to the second operator, who injects the blood into the recipient. Having injected the contents of the syringe, he passes the empty syringe to an assistant, who thoroughly washes it out in sterile normal saline. While the second operator is injecting the first syringe of blood, the first operator fills a second one, and so on. The total amount of blood transfused is easily calculated by the number of syringes that have been filled and emptied.

Lindeman claims that by this method of his a transfusion can be done more quickly and will give rise to fewer and less pronounced reactions than by any other.

The drawbacks to this method are that it requires two skilled operators and two skilled assistants, and that the slightest hitch in the smooth running of the operation will inevitably be complicated by clotting of the blood in one of the needles or one of the syringes. But given all the various requirements, this method is undoubtedly a good one, as the patient receives unaltered blood which has only been a very short time outside the body.

ii. By using Kimpton-Brown's paraffined tube. The success of the operation by the previous method depends on the speed with which the syringes are filled and emptied so as not to allow the blood to clot. In using Kimpton-Brown's tube, clotting is prevented, or at any rate considerably delayed, by the coating of the inside of the tube with a thin layer of paraffin wax. The tube is a cylinder of 500-c.c. capacity, the upper end of which is closed with a rubber cork. Just below the cork is a side tube to which an ordinary double-bulb bellows is attached which is used to expel the contents of the tube. The lower end of the cylinder is drawn out into a cannula point nearly at right angles to the cylinder, and through this the blood enters and leaves the tube. The blood is collected from the donor and injected into the patient by exposing and opening one of the big veins through a skin incision, and inserting the tube directly into the vein.

There are two serious drawbacks to this method : First, the process of coating the tubes and needles is very troublesome, and unless the coating has been done perfectly, clotting will take place. Secondly, the damage done to the veins of donor and recipient, especially in the case of a patient who requires a number of transfusions, is a serious matter. This disadvantage can be avoided by connecting a rubber tube and needle (which of course must both be paraffin-coated) to the tip of the cylinder, in which case a single veno-puncture is the whole operation required ; but one has to take the greatest care not to bend the rubber tube and produce cracks in the paraffin-coating.

b. With the Admixture of some Anti-coagulant.—Although the introduction of the two previous methods undoubtedly marked a great improvement in the technique of transfusion, they still required too great a degree of technical skill in avoiding the much-feared coagulation of the blood to permit transfusion to become universally practised. The idea of preventing this possibility of clotting arose in a fairly early stage of transfusion, and many attempts have been made with a variety of substances, all of which were failures, as the substances used proved to be more or less toxic. Not until 1914 was this problem solved, when sodium citrate was introduced. Experimentally it was proved that : (1) A 0·2 per cent solution of sodium citrate prevents coagulation of the blood outside the body for more than twenty-four hours, even up to three days ; (2) Five grm. of sodium citrate can be introduced safely into an adult without producing toxic symptoms. These two facts have entirely revolutionized the whole problem of transfusion, and have transformed it

from a skilled operation requiring very painstaking preparation into a fairly simple proeedure within the reach of a wide range of workers, and one that has been proved to be quite as effeetive as whole-blood transfusions in its therapeutic effects.

Most of the apparatuses used in the citrate method are based on the 'Robertson's bottle.' This method is an extremely simple one, but the great objection to it is that in colleeting the blood from the donor it is allowed to drop into a sodium eitrate solution of from 2 to 4 per eent, and sometimes one of much higher pereentage. Although no definite alterations can be demonstrated in blood so treated, the high percentage of reaetions—in 20 per cent of the transfusions—whieh occurs with this method is strong evidenee of the formation of some harmful produet.

A very simple apparatus with whieh a transfusion ean be done without any assistanee at all, and where the mixture of the sodium citrate with the blood is made gradually and aeeording to the flow of blood, is that of the late Dr. A. E. Stansfeld.

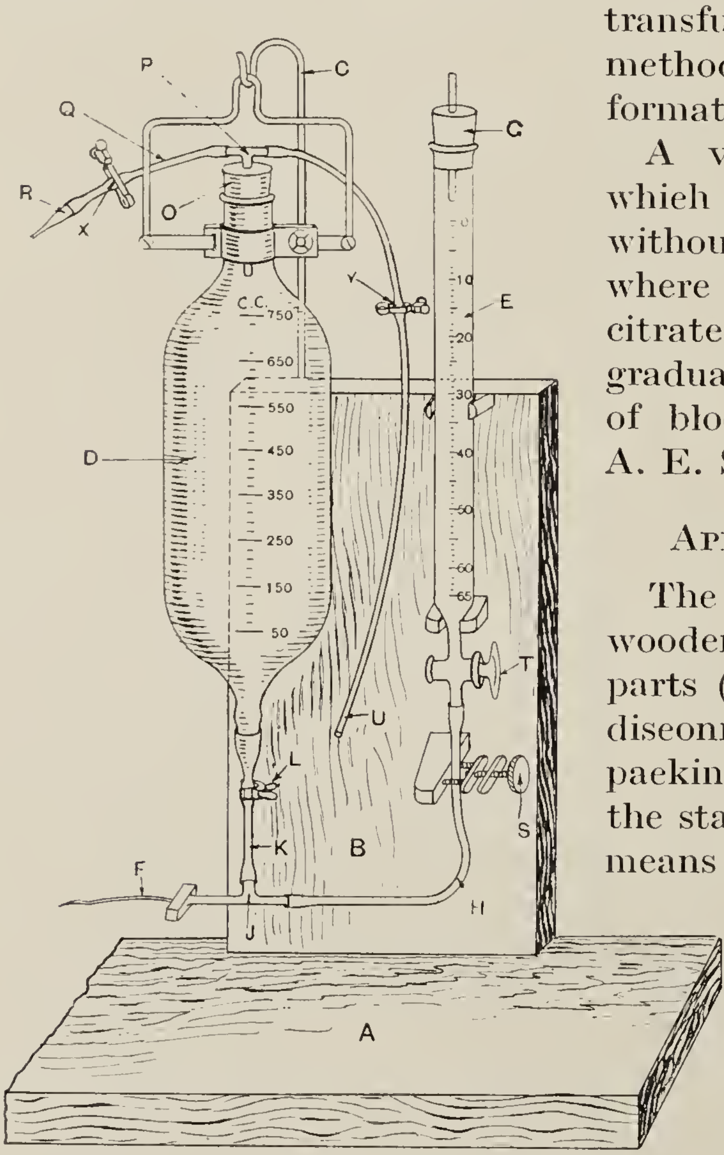


Fig. 15.—Blood Transfusion Apparatus.

Apparatus and Technique.

The apparatus consists of a wooden stand (*Fig.* 15), the two parts (A and B) of whieh are easily diseonneeted for convenienee of paeking. To the baek of part B of the stand a support (C) is fixed by means of a serew, which allows this support to be elevated or lowered according to need. This support earries the graduated glass cylinder (D) into which the donor's blood is eollected. Also attached to B is a burette (E), from which a regulated flow of the eitrate solution joins the current of blood as soon as it leaves the needle (F). At the upper end this burette is fitted with a rubber cork (G), at the lower end with a rubber tubing (H) which, passing through a serew-elip (S), eonnects the burette with one limb of a glass T-piece (J), a seeond limb of whieh is eonneeted with another rubber tubing (K) to the reeeiver (D), whieh latter tube is closed by a bulldog-clip (L). Into the third limb of the T-piece a wide-bore needle (F) with specially ground base fits tightly. The needles are

of a specially curved shape, so that their position in the vein may be easily maintained without danger of wounding the opposite wall. Lastly, the receiver (D) is fitted with a rubber cork (O) through which passes a glass T-piece (P). To one limb of this latter is attached a short rubber tubing (Q) fitted with a tapering glass tube (R), whilst the other limb is connected with a long rubber tubing (U), both of which tubings are closed with clips (X and Y). Before use, the receiver, burette, rubber corks, tubings, and needles should be sterilized by steaming or boiling.

Before starting the transfusions the flow of the citrate solution through the needle should be regulated so as to secure a rate of about three drops per second. This is done by filling the burette (E) with the sterile 5 per cent citrate solution in distilled water, turning the tap (T) wide open, and screwing up the screwclip (S) until the desired flow is secured. The tap is then closed again and the citrate in the burette is made up to zero.

Patient and donor should lie comfortably on beds, preferably not in the same room, as this is apt to upset the former, especially in a case where a relative is the donor. A suitable vein, usually at the bend of the elbow, is chosen and the skin thoroughly cleaned with ether. When the donor's arm has been congested by the application of a tourniquet* above the elbow, two or three drops of a 5 per cent novocain solution injected intradermically at the site of the puncture (larger quantities may obscure the vein) are quite sufficient to anæsthetize the skin. The donor is placed on the side of the bed away from the arm to be used, so as to allow sufficient room on the bed for the apparatus. A folded towel is placed on the base of the stand (A) and the donor's arm stretched out on it. The position of the stand and the height of the receiver are adjusted so that there will be no drag on the needle when it is in the vein, or any kinking of either tube (K) or (H). After having produced a slight negative pressure in the receiver (D) by suction by the mouth at tube U (with clip Y opened), the needle is now pushed into the vein. As soon as it is in, the clip (L) is removed and the tap (T) opened, and the flow of the citrate in comparison with the rise of the blood in the receiver is noted, and, if necessary, re-adjusted by means of the screw (S) so as to allow 1 c.c. of the citrate solution to every 15 to 20 c.c. of blood. If the negative pressure in the receiver is kept up by sucking at tube U every now and again, and if the patient works the muscles of his forearm by clasping and unclasping his hand, a continuous and regular flow of blood will be secured which will ensure the collection of any desired amount up to 700 or 800 c.c. in ten to fifteen minutes. In the great majority of cases healthy individuals such as are usually chosen as donors will easily stand the

* A very simple and convenient tourniquet is that designed by Canti, obtainable from Messrs. Maw, Son & Sons, Aldergate Street, London, E.C.

loss of this amount of blood without any inconvenience other than a feeling of lassitude, but every now and again it happens that seemingly quite healthy and strong donors will faint if more than 400 to 500 c.c. are withdrawn. It is therefore advisable to control the donor's pulse during the withdrawal of the blood. As long as the pulse is observed to maintain its quality and quantity one can safely proceed, but as soon as an appreciable difference is noted in the rate and quality of the pulse, no more blood should be taken from the donor, as this is a sure sign that he has given as much as he can spare without great inconvenience or harm to himself.

When enough blood has been collected, the tourniquet is released, the clip (L) and the tap (T) are closed, the needle is withdrawn, and pressure is maintained with a sterile swab over the site of puncture for a few minutes ; this will stop any further bleeding. The donor should be kept lying on his back for about half an hour and given some stimulant like coffee, tea, or wine, but beyond this no other precautions are necessary.

After the withdrawal of the needle from the vein, the tap (T) is opened and the screw (S) widely unscrewed so as to flush out the glass T-piece (J) and the needle. As a rule it is advisable to replace the needle by a smaller one at this stage. The double bellows are attached to the glass tube (R), and the apparatus is then transferred to the patient. The first part of the procedure with the recipient is identical with that applied to the donor up to the introduction of the needle into the vein, except that occasionally in very anæmic patients the veins are extremely difficult to find and one may have to cut down to the vein and insert the needle through a little cut in the vein wall. As soon as the needle has been introduced, the pressure on the patient's arm is released, clips L and X are opened, and the blood is gently pumped in with the aid of the bellows. Allowing about ten to fifteen minutes for the introduction of 500 c.c. of blood, the whole procedure of a transfusion of this amount should usually be completed in about half an hour.

When a transfusion has to be performed on a little child, the same method can be applied, using a still smaller needle to fit the veins. The veins in the elbow are often too small, and in such cases I have found the internal saphenous vein near the ankle a very convenient one to use. As a matter of fact, since learning how easily accessible this vein is I have used it in transfusing very stout people, in whom the cubital veins are often extremely difficult to find. In infants, too, this vein can be used, but as a rule I prefer the superior longitudinal sinus, introducing the needle through the anterior fontanelle. The baby's head should be firmly held to prevent it from moving and thus causing the needle to slip out or to pierce the veins. In this method it is, of course, imperative absolutely to convince oneself that the needle is in the vein before starting to inject the blood.

As regards the quantities of blood to be injected, this should be

determined for each case separately; but as a general rule large quantities of 750 to 1000 c.c. should be given in cases of acute anæmia through loss of blood, so as to replenish the lost fluid, whereas smaller quantities of 200 to 300 c.c. are indicated in those cases where stimulation of the bone-marrow is required. These figures are for adults; in children and infants proportionately smaller quantities are indicated.

Reaction after Transfusion.

The reactions which follow the injection of incompatible blood may be of a very serious nature, but need not be discussed here, as they can and should be prevented by proper classification of the persons concerned. But even after careful matching of the bloods, and especially in patients who require repeated transfusions, reactions may occur, as has been previously pointed out. These reactions may vary from a slight rise of temperature and the feeling of warmth or of tingling in the fingers and toes to high temperatures accompanied by rigors.

In the milder degrees of reactions no treatment is required, while in the more pronounced ones the administration of 10 to 15 gr. of aspirin or occasionally morphine hypodermically is all that is needed.

INFUSION OF SALINE.

If for any reason blood transfusion is impossible or contra-indicated, the infusion of saline, although very inferior, can be used.

Strictly speaking, this saline solution or 'artificial serum' should have the following composition:—

Potassium Chloride	0·03	Calcium Chloride	0·01
Sodium Chloride	0·60–8·00	Water	100·00

and can be readily obtained in the form of tabloids or powders; still in a case of emergency a solution containing 1 drachm (1 teaspoonful) of salt to 1 pint of boiled water is satisfactory.

There are three recognized ways of administering this saline solution for the treatment of severe hæmorrhage or shock: (1) Into the veins; (2) Into the subcutaneous tissues; and (3) Into the rectum. The selection of the appropriate method must depend upon the urgency of the case. Where an immediate crisis is impending, the venous route should always be selected.

Certain general principles must govern the injection of saline, whether into the veins or the subcutaneous tissues.

First, the most rigid asepsis is to be observed. An operation of this kind, frequently undertaken in a hurry, is often performed without proper regard to this all-important detail.

Secondly, the fluid must reach the body at a temperature above the normal 98·7° F. In hæmorrhage and shock the temperature is subnormal, and the injection of a large quantity of fluid which may tend to lower the body temperature still further is positively harmful.

Whatever apparatus be used, due allowance must be made for the cooling of the fluid as it passes along the tube ; and if an irrigator be used with six feet of tubing, the temperature of the fluid in the irrigator should be at 100° F.

Thirdly, the fluid must not be injected too quickly. In the cases where it is injected into the subcutaneous tissues, a too rapid injection can be readily detected by the swelling of the tissues, since, if injected at the proper rate, the fluid is almost immediately absorbed. On the other hand, when the injection is made into the vein, there is no such indication, and if the saline be forced or pumped in at too great a rate there is a risk of causing failure of the right side of the heart. The average rate should be 1 pint per $\frac{1}{2}$-hour into the subcutaneous tissues ; 1 pint per $\frac{1}{4}$-hour into the veins.

Fourthly, the quantity. Except in children it is no use injecting a smaller quantity than two pints, but it is often advisable to inject considerably more than this ; four, six, and even ten pints have been injected with benefit during a period of twenty-four hours. Starting with two pints as a minimum, the amount can be increased until the state of the pulse shows a satisfactory condition. Provided the fluid is injected slowly the quantity produces no ill-effects. It is the 'rate' of the injection that matters.

The greatest care must be taken to exclude the entrance of air.

Apparatus and Technique.—

Intravenous Apparatus.—Two forms are in common use :—

1. A pump with a two-way tap, connected to the cannula by a short length of rubber tubing.

2. A glass irrigator, holding half a pint, connected by six feet of rubber tubing.

Instruments in use with both : Cannula, scalpel, scissors (sharp-pointed), forceps (one pair toothed), director, and aneurysm needle.

Everything connected with the operation must be boiled.

Of the two forms of apparatus the simpler irrigator, which has no taps or nozzles to get out of order, is the best. With regard to cannulas there is a large assortment, all of which are sufficiently serviceable; but a very simple instrument, made by Messrs. Weiss, of Oxford Street, is to be recommended. The special peculiarities of this instrument are a hollow shaft bent at an obtuse angle on the connecting portion, the shaft tapering to a solid blunt point with an opening at half to one inch from the end (*Fig.* 16). The blunt tapering end greatly facilitates the introduction of the instrument, while the tapering shaft allows it to plug the opening in the vein, there being no necessity for the use of ligatures.

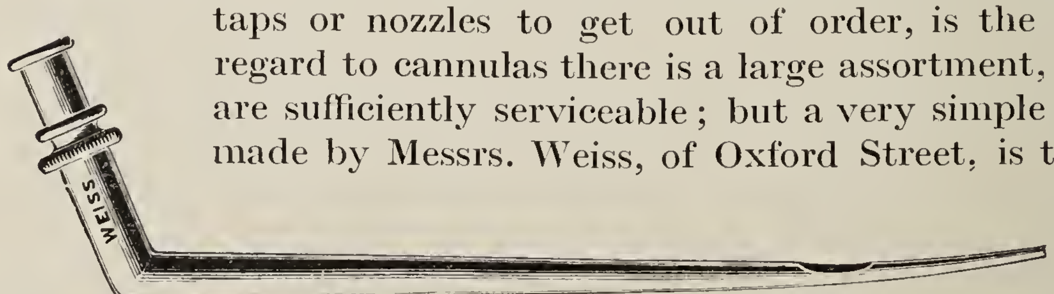


Fig. 16.—Cannula for Intravenous Transfusion.

The *technique* is as follows :—

The cannula is connected to the irrigator by six feet of rubber tubing, this length being necessary in order to start the flow into the vein in those cases where the circulation has failed. The irrigator, tube, and cannula are all filled with hot saline, and held in readiness, a clip or a finger being applied to the tube close to the cannula.

The skin over the vein selected—usually the median basilic or median cephalic—is carefully cleansed, and if the vessels are very collapsed a bandage is placed round the arm to distend them.

A small oblique cut is made through the skin over the vein, and a few touches of the knife allow of the vein being cleared sufficiently to enable it to be grasped with toothed forceps. Traction is now made on the vein with these forceps, so that an angle is formed at the point where the forceps hold it. With a sharp-pointed pair of scissors a small snip is made into the vessel a quarter of an inch *distal* to the forceps, and the flow of blood from the vein shows that the lumen has been reached.

The cannula, already filled, is now introduced through the opening made into the vessel, and pushed on proximally, i.e., towards the shoulder, until the larger calibre of the shaft completely blocks the opening. The irrigator is raised, and the fluid is allowed to enter at the rate advised.

Should there be a smart flow of blood on opening the vein, traction on the wall will almost always arrest it. Needless to remark, before the saline is allowed to flow, the bandage must be removed from the arm. As soon as the flow has been started, the irrigator should be lowered so that the fluid passes slowly into the vein.

While the injection is being made, one or two silkworm-gut sutures are introduced into the edges of the incision, to be ready for tying when the operation is concluded.

As soon as a sufficient quantity has been injected, the cannula is withdrawn, an assistant presses over the distal part of the vein, the sutures are tightened, and the application of a pad and bandage to the wound with the elbow flexed completes the proceedings. We claim for this method absolute simplicity, no difficulty in the introduction of the cannula, and no need for any ligatures : the wound is treated as an ordinary venesection wound. A considerable experience of this modification of the operation has verified our expectations. It can be done under local anæsthesia with the greatest ease.

If the older and more complicated method be adopted, it is first necessary to see that the two-way syringe is in proper working order, as it is exceedingly liable to get out of gear.

The end *c* (*Fig.* 17) is placed in a reservoir containing the saline solution, and the stopcock *b* (two-wayed) is turned so that the end *d* does not communicate with the interior of the cylinder, but only the tube *c*. The piston is slowly drawn out at *a*, so that the fluid fills the interior of the syringe. When it is full the tap *b* is turned so as to

shut off the tube *c*, and to place *d* in direct communication with the chamber ; pressure on the piston will force the saline along *d* and out of the cannula.

The vein is exposed as before described, but in this instance it is necessary to isolate it completely, and to place two ligatures around distally and proximally, about an inch of vein intervening. The distal ligature is tied.

The vein is opened either with scissors or a knife, and the point of the cannula inserted. If the ordinary cannula be used there is often some difficulty in getting it into the lumen. The proximal ligature is now tightened, so fixing the cannula in the vessel, and the fluid is forced into the circulation by the pump, the manœuvre described in connection with the filling of the chamber being repeated when it has been emptied. After a suitable quantity has been injected, the cannula is withdrawn, the proximal ligature is tightened, and the wound closed with silkworm-gut sutures. The chief advantage of this method is the accurate way in which both the amount and rate of the

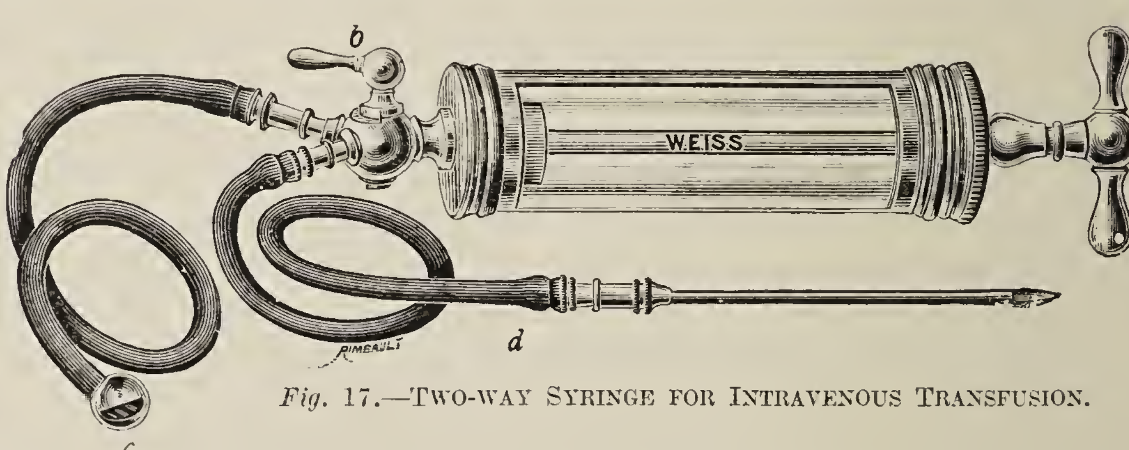


Fig. 17.—Two-way Syringe for Intravenous Transfusion.

injection can be gauged, but we consider it unnecessarily complicated.

Owing to the frequency with which drugs such as salvarsan and its substitutes are injected into the veins, a technique has been developed which does away with the necessity for exposure of the vein by dissection. The vein being rendered prominent by proximal pressure, a sharp hollow needle is thrust through the skin and then into the vein ; its position in the venous channel is recognized by the escape of blood through the open end of the needle. A little manipulation will now allow the operator to pass the needle well into the lumen of the vein.

This method in expert hands is very satisfactory ; but the beginner will often fail, especially in cases where the veins are not prominent, and in such instances it is wiser to cut down and dissect out the vein.

Subcutaneous Injection.—In this method we nearly always make use of the irrigator, but attached to the rubber tubing we have a sharp exploring needle of fine calibre. Both the irrigator and the tubing are surrounded with packing to preserve the heat, and it is a good plan to stand the irrigator in a bowl of hot water on a shelf or table above the level of the patient.

An ingenious apparatus can be made out of a large glass flask, a tripod, and a nightlight, and the saline can be kept at a uniform temperature, or one of the modified 'Thermos' flasks which are advertised can be employed.

A convenient spot is selected, usually the submammary region, and the needle is thrust sharply into it. If it has been properly introduced, the fluid will soon start running, and the rate must be controlled by raising or lowering the level of the irrigator.

Careful watch must be kept on the chest, so that the tissues are not unduly distended ; but if the injection is allowed to run slowly, it is usually possible to get in about three to four pints without much inconvenience to the patient. We insist strongly on the fact that if pain is caused it is because the fluid is running too quickly. If it is necessary to repeat the operation, the opposite breast or region of the buttock may be selected.

Injection per Rectum.—Fluid introduced into the rectum is readily absorbed, and we make use of this channel for the introduction of saline under a number of circumstances which will be referred to later. For the present it will be sufficient to indicate the two chief ways by which the injection is effected.

Interrupted Injections.—Plain enemata of one to two pints slowly introduced into the bowel and allowed to remain.

Continuous Irrigation into the rectum by means of an irrigator and tube, as in the preceding operation, a soft rectal tube or catheter being substituted for the needle. Saline given in this way is very valuable in cases of collapse, hæmorrhage, or toxæmia, and it is surprising how readily great quantities can be absorbed, and with what benefit to the patient.

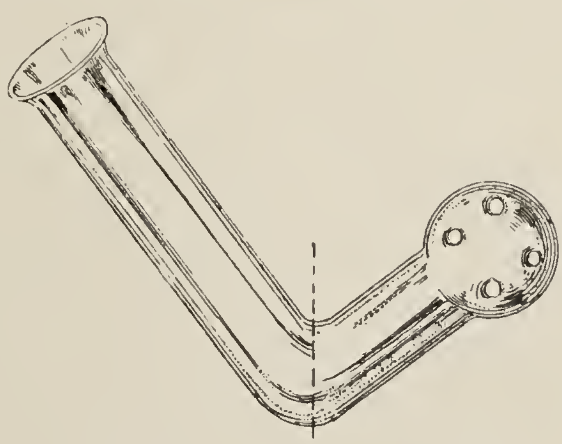


Fig. 18.—Cannula for the Administration of Saline per Rectum.
(Only the portion beyond the dotted line lies within the lumen of the bowel.)

Raising of the pelvis not only assists the introduction of the fluid, but it helps the patient to retain it.

The method of injecting saline into the rectum in a continuous manner is now largely employed in the treatment of cases of peritonitis, with excellent results. The patient is propped up in bed in Fowler's position, and a glass tube bent to a right angle three inches from the rounded end, as illustrated in *Fig.* 18, is introduced into the rectum. The tube is connected to an irrigator, or some other form of apparatus which maintains the saline at a temperature of 103° to 110°, according to the length of tubing through which it has to pass. The saline is then allowed to flow slowly into the bowel, from which it is absorbed and carried into the circulation ; the rate of flow is regulated

by the height of the reservoir, very little pressure being employed ; this allows the patient to expel flatus. As much as seven or eight pints may be absorbed in twelve hours, but the flow must be regulated so that the fluid does not distend the bowel, only to be ejected later.

This treatment may be maintained with advantage for several days. In some cases it will be found that the saline cannot be retained at all ; the prognosis is very grave in these circumstances, the patient rarely recovering—but as a substitute for the rectal method that of subcutaneous injection should then be employed.

It is better to use a rounded glass nozzle with several perforations than a rubber catheter, and during the interruption that may be required in the administration of the saline the nozzle may remain *in situ.*

The calibre of the tube must, however, be small, or else it will irritate the sphincter and the patient will reject the saline. We find the most convenient size is one corresponding to a 16 English catheter gauge.

Later Treatment.— In cases of hæmorrhage we have : (1) To promote rapid formation of new blood ; (2) To prevent waste of tissue as far as possible.

1. *To Make Fresh Blood.*—By the introduction of blood or saline we can make up for deficiencies in quantity ; the quality, however, remains poor. To improve this, we must feed our patient on highly nutritive foods : strong beef extracts and jellies, burgundy and other stimulants. Iron or iron and arsenic should be given as soon as possible in the form of hæmatogen or hæmaboloids ; later, the tartrate and perchloride may be substituted for them. One important point is to see that the patient *has plenty to drink.*

2. *To Prevent Tissue Change*, or work of the body of any kind, is also important. Absolute rest and quiet must be kept up for some days ; in many cases moderate doses of opium will be found very useful.

CHAPTER V

OF SYNCOPE, SHOCK, AND COLLAPSE

MUCH confusion has existed regarding the exact meanings of these terms and the pathological changes which bring about these conditions. The recent observations of Crile and Mummery have certainly given us a better idea of some of the factors which are important in producing them. Generally speaking, there is much clinical similarity between the three, but the causes which lead to the individual variety, and the results of treatment, are vastly dissimilar.

Syncope is a temporary inhibition of the vital functions, produced, it appears, by an anæmic state of the brain. Whether this anæmia is the outcome of changes in the pial vessels or of loss of blood which has been poured out into the splanchnic area is not clear, nor is it of much importance.

Practically an attack of syncope or fainting is a temporary condition, soon recovered from if simple measures are resorted to. These measures consist in lowering the head below the level of the body, or in forcing it between the patient's knees when he is sitting down. Some stimulant—a drachm of the spiritus ammon. aromat., or half an ounce of brandy in water—is sufficient. As the attacks are likely to recur, the patient should rest for the remainder of the day.

Sometimes a similar condition to this occurs under anæsthesia, and has been called chloroform syncope. How far this has been confused with shock it is difficult to say, but undoubtedly we meet with cases of transient failure of pulse and respiration before any operative procedures which can produce shock have been attempted ; and as is well known, elevation of the head of the patient while under the influence of chloroform is often serious owing to the anæmia of the brain which is caused thereby.

The general treatment of such cases will clearly be on the same lines as when no anæsthetic has been administered, but the danger is considerably greater under such circumstances, since the various systems of the body do not so readily react when under the influence of an anæsthetic. The head should be lowered, artificial respiration performed, and strychnine administered hypodermically. In addition to these measures, a very hot compress applied to the head will be found effective.

Shock appears to be a condition of lowered blood-pressure of gradual onset and prolonged duration, brought about by exhaustion

of the vasomotor centres. It is chiefly produced by violent or prolonged manipulation of the contents of the abdomen, or by damage to the nerves or the great nerve trunks of the body. The injurious impulses thereby generated appear to act upon the central nervous system, so that the vasoeonstrietor centre ceases to exert any effect upon the peripheral vessels of the body ; a great fall of blood-pressure results, and death may occur.

Collapse appears to be a *sudden* failure of the vital functions or, as Crile puts it, " immediate depression or death." There are many causes which bring about this condition—injury to the heart, damage to the respiratory mechanism, *profuse hæmorrhage*, *anæmia of the vasomotor centres as the result of sudden dilatation of the splanchnic vascular area.* All these conditions which produce collapse are important in influencing the incidence of shock at a later date.

Briefly, we may say collapse comes on suddenly ; there is great depression, but if appropriate remedies are adopted it will soon pass off. Shock, on the other hand, comes on later ; its development is often favoured by a previous state of collapse ; it is of longer duration, is much more serious, and is more difficult to treat.

Preventive Treatment.—Before proceeding to the general treatment of these accidents after they have occurred, we must see what precautions may be taken to avoid them. Clearly the preventive treatment for collapse is to check all bleeding as soon as possible, from whatever source or under whatever conditions it may occur.

With shock, on the other hand, we may adopt a number of measures whieh are of undoubted prophylactic value.

1. Before any severe operation the patient must be well wrapped up, and the exposure during the operation be reduced to a minimum.
2. The patient should be kept as dry as possible. Too often he is swamped with lotions, which soon cool down and chill the surface.
3. An injection of morphia $\frac{1}{6}$ to $\frac{1}{4}$ gr., and atropine $\frac{1}{150}$ to $\frac{1}{100}$ gr., should be given.
4. All lotions used for the patient during the operation should be at or above the normal temperature of the body.
5. Purging and starvation, which form part of the routine preparation of a patient before operation, should be curtailed. Often it is advisable to feed a patient a few hours before the performance of a serious operation.
6. Injections of saline with the addition of adrenalin may be given either into the veins or the submammary tissues, or a 6 per cent solution of glucose may be substituted for the saline.
7. It may be advisable to inject a 4 per cent solution of eucaine into the main nerve trunks of a limb previous to the performance of the operation—a procedure which is said to be very valuable in blocking the nerve trunks and preventing the injurious impulses from affecting the higher centres.

Crile's Technique for Preventing Shock.—Crile's work on shock has shown that, to a large extent at any rate, it results from injurious impulses passing up from the site of operation to the brain via the nerves. The condition is of course favoured by loss of blood and exposure to cold. To obviate the passage of these impulses, Crile's procedure is briefly as follows :—

1. Preliminary narcotizing with morphia gr. $\frac{1}{4}$, scopolamine gr. $\frac{1}{150}$ to $\frac{1}{100}$.
2. Nitrous oxide and oxygen anæsthesia.
3. Infiltration of the track of incision with 1–400 novocain—a non-toxic solution.
4. Infiltration as far as possible of all the deeper structures, including mesenteries, etc.
5. Final infiltration with quinine and urea $\frac{1}{2}$ per cent solution before closure of the wound, to prevent post-operative pain.

This last step is often omitted owing to the irritative effects of quinine on the tissues.

Remedial Treatment.—When once shock has supervened—as shown by the slow, weak, often imperceptible pulse, the blanched surface, the feeble respirations, the loss of control over the bladder and rectal sphincters—remedial measures must be adopted. Allowing that our explanation of the cause of shock is correct, clearly we must endeavour to raise the blood-pressure, and trust to the final recovery of the higher centres if we assist them in their work, as we apply artificial respiration until the respiratory centre continues of its own accord.

The most valuable form of treatment is the injection of saline as before described, and in addition to the three methods of injection described in the last chapter, we may, in abdominal operations, make use of a fourth route for the administration of this fluid, by injecting it into the peritoneal cavity, from which it is soon absorbed.

The addition of adrenalin to make a solution of 1–50,000 to 1–100,000 has a marked, but unfortunately transient, effect.

Two-grain doses of Parke Davis's aseptic ergot may be added with advantage to the saline. The effect of the drug is more lasting than that of adrenalin. In addition to these measures, the head should be kept low, the limbs bandaged, and the abdomen, when possible, tightly compressed with a broad binder.

Pituitary extract is also used to raise the blood-pressure. This is a valuable drug, but it must be used with great caution (*see under* 'Meteorism').

The value of strychnine in cases of shock, either as a preventive or remedial measure, is difficult to estimate. If employed it should only be used in conjunction with the administration of normal saline and blood transfusion. Inhalations of oxygen are exceedingly valuable.

The effect of lowering of the body temperature on the development of shock has already been noted ; conversely, the value of heat as a

remedial treatment has now to be emphasized. In all cases of shock the body must be kept warm, and in very bad cases a hot-air bath made by suspending an ordinary electric light inside a cradle covered with blankets has been proved to be of great service.

The treatment of collapse is similar to the above, but owing to the more transient character of the vasomotor paralysis, a quicker response and a better result are to be anticipated.

The similarity between the collapse after an internal hæmorrhage and the shock of a severe abdominal injury can now be more fully appreciated, and the difficulty in deciding on the diagnosis and treatment will be more obvious. Clearly, until such diagnosis has been made, active treatment must be suspended, but we would again insist that, when the patient's condition is so serious that a fatal issue seems imminent, the various remedies for shock suggested above must be adopted even in the absence of a decided opinion.

CHAPTER VI

OF STYPTICS AND OF THE ACTUAL CAUTERY

IN former editions of this work many pages were devoted to the consideration of styptics, or substances which, by their application to a bleeding surface, had some effect in promoting coagulation. Formerly many such drugs were freely employed by the surgeon, some being very unpleasant, painful, and even harmful, and it is no longer looked upon as good surgery to make use of the messy preparations of iron and tannin that were once employed. We shall therefore briefly consider here only a few styptics which are now applied.

Mechanical Styptics.—*Collodion*, prepared by dissolving one part of pyroxylin in a mixture of thirty-six parts of ether and twelve parts of rectified spirit, is extremely useful in cases of wounds about the face in which, if a scar has to be avoided, the edges have not only to be brought together, but must be held together firmly enough to prevent blood being effused between them. This is readily done by painting three or four coats of this collodion over the wound with a camel's-hair brush, or by saturating a piece of lint in it and applying it to the wound. The collodion as it dries contracts, and thus the required pressure is kept up.

Flexile collodion, prepared by adding to 12 oz. of collodion ½ oz. (by weight) of Canada balsam and ¼ oz. (by weight) of castor oil, may be used instead of the above. It is not so liable to crack, but is not so contractile as ordinary collodion.

Gauze Wool acts as a hæmostatic—the fibres giving numerous points from which the process of coagulation can start. When impregnated with some antiseptic body it is very generally used.

Drugs.—Five drugs are of service when applied locally to a bleeding surface, and they are the modern survivors of a long list of twenty or thirty varieties of past decades : (1) *Adrenalin Chloride*, (2) *Gelatin*, (3) *Hamamelis*, (4) *Antipyrin*, (5) *Turpentine*. These are fairly efficient styptics ; and in the case of antipyrin there are certain analgesic properties which are very valuable.

1. *Adrenalin Chloride* is prepared from the medullary part of the suprarenal capsule, and contains the active principle of the gland, which, according to the experiments of Oliver and Schäfer, even in minute quantities causes an increase of the blood-pressure by constricting the arterioles. This property renders it of considerable service in cases of shock (*see* pp. 58, 59).

Locally, it acts upon the vessels, causing them to contract, and so it checks the hæmorrhage. It is used most frequently in operations

upon the eye and nose, when it is combined with cocaine. It can be obtained in standard 1–1000 sterilized solution, and for use should be diluted 1–5000 to 1–10,000, according to the amount of bleeding and the size of the bleeding surface. In large doses it is toxic.

2. *Gelatin* has been described (*see* pp. 25, 34). It is one of the best styptics we possess.

3. *Hamamelis* can still be accused of being somewhat dirty and unpleasant. It is of value in washing out a bleeding cavity such as the bladder, one ounce of the extract being added to a pint of hot saline.

4. *Antipyrin* is largely used by several French surgeons, who speak highly of its value. It can be applied in powdered form, or made up into an ointment with an antiseptic basis.

5. *Turpentine* is an old-fashioned remedy, but in cases of oozing from granulation tissue or septic wounds it is certainly of great value. The wound should be plugged with gauze soaked in turpentine. The application is painful, and a full dose of morphia should be given.

With regard to the general application of the above we would say, *never rely on a styptic when any simple surgical procedure can be used as an alternative.*

The Application of Cold to a bleeding part has always been recognized as one of the most valuable means of arrest. Free exposure to the air is often alone sufficient to promote coagulation of the blood and constriction of the blood-vessels. This may be seen in cases of recurrent hæmorrhage after an amputation or any other large cutting operation, when a few hours after the operation the wound or the flaps become distended with blood, which may be dripping away at quite an alarming rate. In such a case, if the flaps be opened and the clots cleared out, so that the air can get to the surface of the wound and to the ends of the vessels, the bleeding will very probably cease without anything further being done, provided, of course, that no big vessel has been overlooked.

A very efficient way of applying cold is by means of the *Ether Spray*. The effect of this spray should not be pushed so far as to cause the parts to be absolutely congealed, if this can be helped, for they become very painful on thawing, and the blood-vessels being partly paralysed the bleeding is apt to recur.

By means of this spray we have seen furious bleeding from a fungating cancer of the breast completely arrested in less than fifteen seconds.

Hot Water.—As a converse to this method of freezing, another way of stopping general oozing is the application of lint wrung out of water as hot as can be borne by the skin, i.e., about 120° to 130° F., but not so thoroughly as to be quite dry, and applied immediately. The mode of action would seem to be a direct stimulation of the vaso-constrictor nerves, or perhaps of the musculature of the arterioles, as a temperature of 100° to 105° is known to produce a tonic contraction

of muscular tissue. The effect of hot-water injections on uterine hæmorrhages is very well understood by obstetricians, and for bleeding from a cavity or an extensive surface a hot irrigation may be employed.

When it is a mere question of choice between heat and cold, or hot water and cold applications, for checking hæmorrhage, heat should always be chosen. The prolonged application of an ice-bag or cold water may seriously injure the vitality of tissues, while the irrigation of a large surface or cavity with ice-cold water, after much blood has been lost, will often bring on severe shock.

Actual Cautery.—We come now to "that cruel and barbarous method" of stopping bleeding which Ambrose Paré denounced, and which is rarely employed in modern surgery.

The principal forms of apparatus for the application of the actual cautery are the galvano-cautery and Paquelin's thermo-cautery.

Galvano-cautery.—This apparatus is a great advance upon the cautery irons, and is itself well enough adapted for the arrest of bleeding.

The principle on which it depends is that platinum, a metal of high resistance and great infusibility, will become red or white hot if a galvanic current of sufficient intensity be passed through it. Even when frequently heated, platinum does not become oxidized.

The wires from a cautery battery are connected by binding screws to the handle of the galvano-cautery instruments. In the handle the wires are continued to the joints which receive the platinum terminals or rheophore. One of these wires is broken, so that only when the knob is pressed or the trigger pulled is the circuit complete. In this way the current passes through the rheophore when the current is brought into action, and then only, whether it be a noose of wire or some other burner. The resistance to this current in the platinum is so great that heat is generated sufficient to cause the wire to become of dazzling whiteness. If the rheophore used be of the kind known as the *Galvanic Ecraseur*, the wire to be heated is so arranged that it can be shortened up like a snare.

Two great advantages are possessed by the galvano-cautery. The first is that a very small pointed rheophore may be used to a limited bleeding surface without its losing heat before it can be well applied. The second is that the wire as a noose can be fitted with the fingers round whatever requires cauterization, before the knob is pressed and the wire becomes hot. This, as may be imagined, is very often an enormous gain. The difficulty of its use lies in keeping the temperature of the wire low enough, when once contact has been made.

The introduction of electricity for lighting purposes has rendered the use of the galvano-cautery much more available, for by suitable apparatus it can be attached to the mains and is thus always ready.

Paquelin's Cautery is a very serviceable means of employing heat. It depends on the principle that when the vapour of benzoline or some other hydrocarbon is driven over heated platinum, its rapid

incandescence is sufficient to maintain this heat very perfectly. In *Fig.* 19 it will be seen that with an ordinary Higginson's syringe and safety ball to give a continuous blast, atmospheric air is blown over the surface of the benzoline, and then, being saturated with its vapour, passes on through the tube and the holder and thence into the platinum point, which contains some spongy platinum.

The platinum point having been first heated in a spirit flame until it just begins to glow, the ball of the syringe is worked by hand, and the air, charged with benzoline, undergoes active combustion as it passes through the point, and thus not only maintains its heat, but increases it to whiteness. The readiest way to heat the platinum is to use the spirit lamp as a blow-pipe flame, for which it is generally arranged. The heat to employ as a styptic is a dull, almost invisible, red.

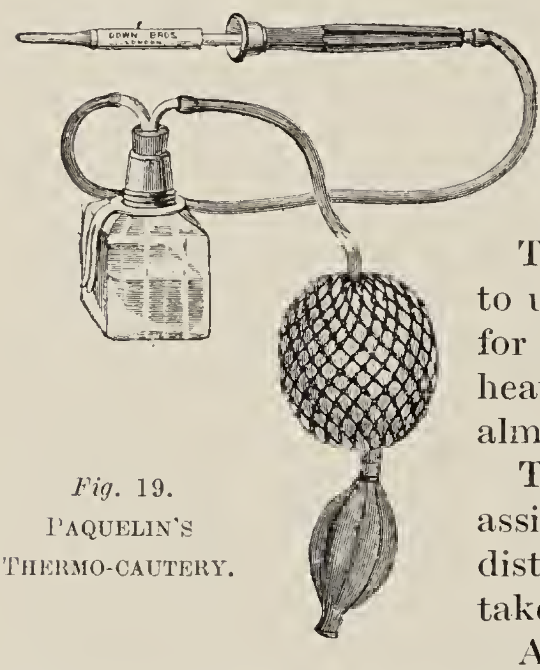


Fig. 19.
PAQUELIN'S THERMO-CAUTERY.

The cautery should be in charge of an assistant who has nothing else to do to distract his attention, and care must be taken that the benzoline is quite pure.

As just indicated, a cautery should be used at a dull red heat for the purpose of checking hæmorrhage, and repeated applications should be made until a firm eschar forms and all obvious oozing ceases.

CHAPTER VII

OF SOME OF THE PRINCIPAL DRUGS USED INTERNALLY FOR THE ARREST OF BLEEDING

A LIST of all the drugs which have been administered with the intention of directly or indirectly arresting hæmorrhage would be found to comprise a very large section of the Pharmacopœia. Such a list, however, unaccompanied by full descriptions of all the cases in which the drugs might individually be indicated, would only be useless. But those now to be mentioned have all proved themselves hæmostatics of more or less power, and a knowledge of their comparative activity is very necessary to the practitioner.

It is, naturally, in cases of internal hæmorrhage that hæmostatic drugs are most often used. It seems unnecessary to employ constitutional remedies when the loss of blood can be mechanically restrained, and so it happens that those remedies which affect the vessels, the vasomotor nerves, the blood, or the cardiac activity, and which may effectually restrain a loss of blood from any part, are brought into service only when the bleeding comes from parts out of reach of surgical interference.

Iron heads the list of the internal remedies for bleeding, and the employment of the perchloride has been so often mentioned that it is unnecessary to do more than remind the student that, as a hæmostatic, the doses must be full, say 30 or 40 drops of the liq. ferri perchlor. It is, however, exceedingly unpleasant to take.

Acetate of Lead, especially when combined with opium, is of frequent use in hæmoptysis and similar bleedings. A common preparation is the pil. plumbi c. opio, in 2- to 4-gr. doses. The proportion of the lead salt in the pill is large (three-quarters of the whole); therefore, although it may be necessary to repeat the dose at short intervals at first, it must not be persevered with for more than two or three days. It is also useful in hæmorrhages from the bowels in enteric fever.

Opium or Morphia has also been used alone in hæmoptysis, given in small and frequent doses, and with very good results. For example, the hypodermic injection of $\frac{1}{6}$ gr. of morphia, followed by injections of $\frac{1}{8}$ gr. at intervals of three hours, is often very successful.

Turpentine is sometimes employed—in doses of 5 to 10 min.—and has been highly recommended for hæmorrhage from sloughing cavities; gauze soaked in turpentine being packed into the wound, which rapidly cleans under the influence of this drug.

Ergot and Ergotine.—The active principle of ergot of rye has a very powerful effect on all organic muscular fibre, and especially on the walls of the blood-vessels, and the uterus. There is no doubt that the dry gangrene caused by eating bread made from 'spurred rye' is due to the prolonged spasm of the arterioles of the extremities. As might be expected, therefore, preparations of ergot are powerful hæmostatics ; the principal ones used are the liquid extract of ergot and ergotine. The former is given by the mouth, in doses of 20 to 40 min. or a drachm, the latter in 1- to 5-gr. doses, generally hypodermically. The liquid extract is most commonly used, but to be trustworthy it must be freshly prepared. The injectio ergotæ hypodermica is prepared from the extractum ergotæ liquidum, B.P. 1898 (which is made with 90 per cent of alcohol instead of rectified spirit), and the dose is 3 to 10 min.

More recently preparations of the active principle of ergot, ergotinine citrate, have been put forward, which can be administered hypodermically in doses of from $\frac{1}{100}$ to $\frac{1}{25}$ gr. It has given good results.

For the special action of ergot on the uterus, and the indications for its employment in hæmorrhage therefrom, and as a stimulant to its muscular contraction, the student is referred to works on midwifery; in hæmoptysis, epistaxis, hæmorrhage from the bowel, the hæmorrhagic diathesis (*see* p. 38), and purpura it may be successfully administered. A combination of ergot and opium is very useful in the hæmaturia caused by growths of the bladder :—

℞	Ext. Ergotæ Liq.	ʒss	Inf. Buchu	ad ℥j
	Tinct. Opii	♏v		

℥j t.d.s.

Digitalis, the constitutional action of which on the arterioles in many ways resembles that of ergot, may also be used as a hæmostatic, especially in hæmoptysis, menorrhagia, and in some forms of recurrent nose-bleeding. It must be given with the same precautions as when employed in other cases. The *tincture* and the *infusion* are the most useful preparations, and there appear to be certain advantages in using a mixture of these, e.g., 10 min. of the tincture with $\frac{1}{2}$ oz. of the infusion for a dose.

Most of the acids used as therapeutic agents, but especially **Sulphuric Acid,** are useful in checking bleeding from various internal organs ; thus the *dilute sulphuric acid,* or the *aromatic sulphuric acid,* in doses of 10 to 30 min., is found useful in hæmoptysis.

In addition to these principal drugs, the following should be mentioned as having a reputation as hæmostatics, but which do not require a detailed description, namely, preparations of **Alum, Gallic** and **Tannic Acids, Ipecacuanha, Creosote,** and **Hamamelis.** This last, prepared from the witch hazel, restrains bleeding of all kinds, internal and external. It is useful in bleeding piles and dysentery, or

in hæmaturia, in doses of about 20 min. to a drachm of the tincture. The value of gallic acid, however, rests on a much surer foundation, especially in cases of hæmaturia. During the last few years **Chloride of Calcium** has been strongly recommended as a hæmostatic, and its use has been referred to already. It is best given intravenously, 5 c.c. of a 10 per cent solution in distilled water; when given by the mouth its effect is uncertain.

In some cases of persistent oozing 5–10 c.c. of **Horse Serum** injected beneath the skin have a very beneficial effect.

SECTION II

OF APPARATUS FOR RESTRAINT AND SUPPORT (BANDAGES, SPLINTS, Etc.)

CHAPTER VIII

OF BANDAGES

THE first part of this section deals with the several kinds of bandages, and the second part with splints in their varieties and modes of application.

On all sides the tendency of modern surgery is towards greater simplicity in dressing wounds, and in other procedures which involve the use of bandages. The number of distinct 'patterns' of bandages is now very much less than we find described even in recent books on the subject, and infinitely less than classical authors considered it necessary to describe and figure. Only those ways of applying bandages which are now in constant use will here be described.

Bandages may be roughly divided into Triangulars or Scarfs, Rollers, and bandages of special form, such as the **T**, the **H**, or the Many-tailed. The material of which they are made is usually grey shirting, i.e., unbleached calico; but roller bandages are often made of flannel, or of some woven material, for greater elasticity or strength, or of muslin for holding plaster-of-Paris, etc.; these, with some other forms of special bandage, will be described later.

The choice of the **Form of Bandage,** and of the **Material,** will depend on consideration of such points as these :—

The Amount of Restraint or Support required. Thus, a simple triangular bandage will serve best to keep a dressing on the scalp, while a twisted or knotted roller will be required to restrain the hæmorrhage from a recent wound there.

The Effect of the Bandage on the Skin and Circulation of the part. Consideration of this point leads to the selection of the material, care as to its tightness, and choice of the best method of applying it. Thus, in a limb likely to swell, an elastic pattern, such as a 'figure of **8**,' will be chosen, while if firmness be most required, the 'turned' bandage should be used.

The Length of Time the Bandage will have to be kept on. If the bandage be for a temporary purpose only, there will not be the same elaboration required as if it were meant to be kept on for some time: in the latter case the particular plan will often be settled from considerations of future cleanliness.

THE TRIANGULAR BANDAGE.

The Triangular or Scarf Bandage is the half of a square of 36 inches, and is usually made of unbleached calico.

The first and most obvious use of this bandage is simply to tie it round where it may be wanted with a reef knot, it having been previously folded up into a *Cravat.* In a case of venesection the arrest of the venous circulation above the incision may be effected by means of this bandage.

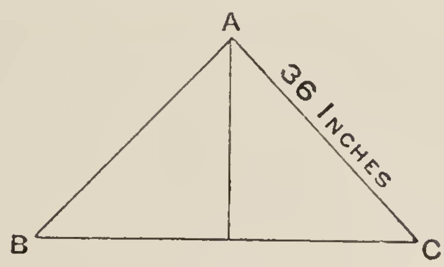


Fig. 20.
The Triangular Bandage.

The *Sling* is another very useful bandage, and very quickly put on; indeed, of all the applications of the triangle it is the most frequently required. Although its application may be shown in a few seconds, a written description of it, as with other bandages and knots, is more complicated.

Let the right-angled corner (*Fig.* 20) be called A, and the upper and lower acute-angled ones B and C respectively. Standing in front of the patient, corner A should be placed in the axillary line on the affected side, midway between the axilla and the ilium; B should reach up to and hang over the opposite shoulder. The line B to C will then hang diagonally across the body, and between it and the arm to be slung. The arm should be placed in the required position, and C brought up over the shoulder on the affected side and tied with B in a bow behind the neck. The elbow should then be kept in position by pinning A round it as shown in the figure (*Fig.* 21).


Fig. 21.—The Sling.


Fig. 22.—Forearm Slung, with the Elbow Hanging Free.

In *Slinging the Forearm* the sling should be made just short enough to elevate the shoulder slightly, or the patient will not trust all the weight of the limb to it. The hand should be a little higher than the elbow. Sometimes, as in fractures of the humerus, the weight of the forearm is used as an extension, while the hand and wrist alone are slung by the bandage folded up into a cravat, three or four inches wide,

and tied behind the neck. *In this case the positions of the end of the sling should be reversed, the anterior going over the shoulder of the unaffected side* (*Fig.* 22).

THE ROLLER BANDAGE.

To bandage neatly is to bandage well, and to be able to bandage well is essential to the practical surgeon. The art of using the roller bandage properly is one not to be learned without practice, even though it be freely allowed that the subject has been quite uselessly complicated by needless rules and patterns.

Materials.—Regarding the materials for these roller bandages, it has been said before that a strip of any stuff which fulfils the conditions of sufficient strength, with lightness and softness, will do. The length of the strip varies from $4\frac{1}{2}$ to 6 yards, the width from 2 to 4 inches ; $2\frac{1}{2}$ and $3\frac{1}{2}$ inches being the commonest sizes ; the larger sizes, 6 inches, are known as 'rib rollers.'

For the purposes of description, roller bandages may be divided into **Elastic, Semi-elastic,** and **Inelastic** kinds.

Elastic bandages, of which there are several kinds, woven, india-rubber, etc., will be found described in a later chapter.

The *Semi-elastic* bandages are either woven in a special manner, or made of a somewhat elastic material. Under this heading come all flannel bandages, domette, cotton, or silk net.

The application of these bandages is much more simple than that of the inelastic, for they will lie smoothly if they are merely rolled on firmly, so that they hardly ever require turning or other manipulation. They should be rolled up rather loosely before use.

The *Inelastic* or common bandages are the most frequently used, especially in hospital, where the other kinds would be too expensive, even if they were firm enough for the requirements.

They are usually made of 'grey shirting' or unbleached calico, or the same bleached ; or, for bandages about the eyes or face, a very cool light bandage may be made of finer cotton stuff or linen. Very old worn damask linen is not infrequently used for covering pads or cushions, and, speaking generally, it may be said that washed stuffs are better than new, which are apt to contain a stiffening dressing. They should always be torn, and no selvedge retained.

The general rule is to use the $2\frac{1}{2}$-in. bandage for the arms and head, the $3\frac{1}{2}$-in. for the legs and pelvis, and the $4\frac{1}{2}$-in. width for the chest and abdomen. Except for the trunk, however, it will be found that the narrowest bandage is the easiest and the most comfortable to apply in all cases.

Application.—In order to apply the *Common Roller Bandage* to any part of the body, the first thing to learn is how to judge of the firmness and support required, and to distribute the pressure evenly about the limb. For this purpose the bandage must always be kept

rolled up (dropping it is a sure sign of a bungler or beginner), and held (as in *Fig.* 26) three or four inehes away from the part, while the finger and thumb are used to retain the bandage in its plaee when it is being applied. The next point is the manipulation known as *turning* or *reversing*, by means of which the bandage is turned over on itself while it is being applied. The object of this turning is that the bandage may lie smoothly, and be firm as well; for inasmueh as all parts of the limbs, ete., are eonstantly varying in diameter, and the edges of the bandage will not streteh to make one side longer than the other, it follows that if it be simply rolled on in a spiral fashion, only the largest diameter of the limb eovered by eaeh turn of the bandage will be grasped by it, and the bandage will be loose elsewhere, as in *Fig.* 23 and the lower part of *Fig.* 25.

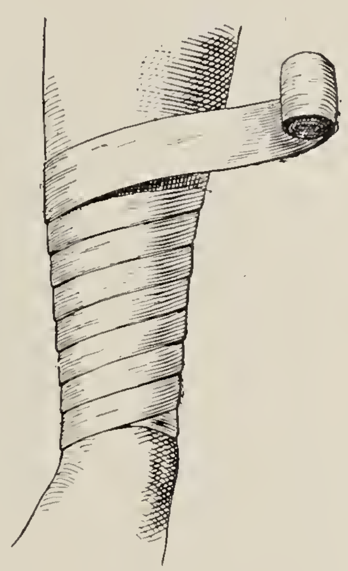


Fig. 23.—Leg Bandaged with a Simple Spiral Roller.

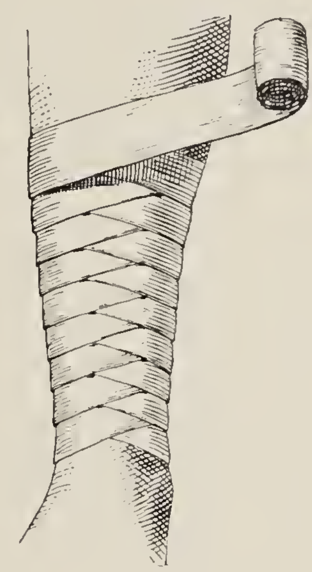


Fig. 24.—Leg Bandaged with the Reversed Spiral.

The latter grasps the limb evenly, the former does not.

To avoid this the bandage is, when neeessary, *turned over* as in *Fig.* 24, and by this means the upper and lower edges are frequently ehanged, so that the whole width of the bandage grips the limb. This turning requires a little knaek, but is easily learned. The seeret of doing it well eonsists in having the portion in the hand (*Fig.* 26) quite loose, so that by bringing the roller down it naturally falls over. The thumb, therefore, must be holding the turn of the bandage last applied during this manœuvre. Moreover, the bandage should be brought aeross the limb with a good slope upwards, say at 45° to the long axis, and the reverse similarly be brought boldly down, so that the bandage is well doubled over, otherwise some of the fold will appear on the other side of the limb when the bandage comes round.

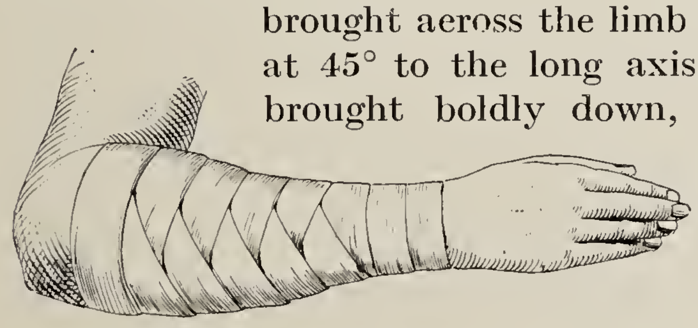


Fig. 25.—Forearm Bandaged Above with a Reversed, Below with a Simple Spiral.

The most common fault is that of screwing the roller round on its own axis, instead of allowing the bandage to fall over into position, as it should do almost of its own aceord.

As a rule it is best to turn every time the bandage eomes round, and the turns should be made in the same straight line, whieh should lie on the outer aspeet of the limb. But these points are not

essential, and indeed both depend rather on the æsthetics of bandaging than on any practical advantage.

General Rules for Bandaging.—Bandage from below upwards, and always have the upper part of the bandage looser than the lower.

Bandage smoothly without irregularities or creases.

Start bandaging from within outwards, except in fractures of the femur and Pott's fracture at the ankle.

Do not bandage a limb underneath splints. There are exceptions to this rule, as will be seen later.

Pass the end of the bandage obliquely across the limb at the start, and fix it with one or two turns round the limb, so that it does not slip.

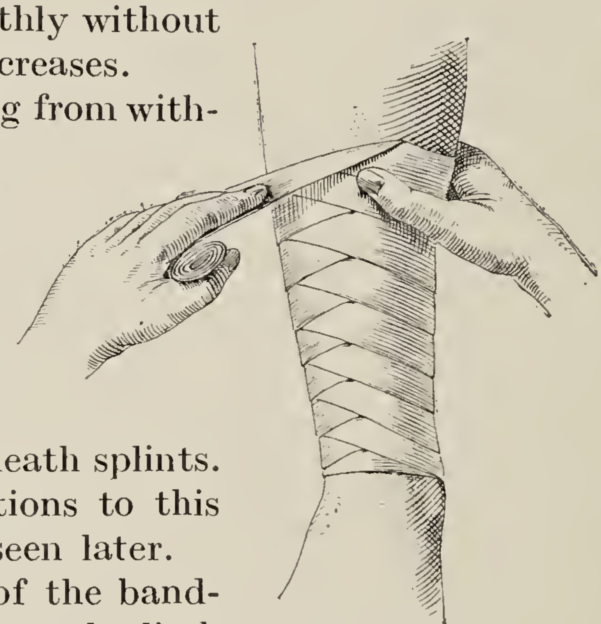


Fig. 26.—Application of the Reversed Spiral.

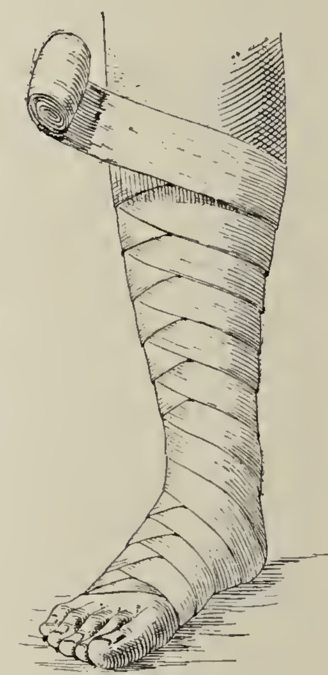


Fig. 27.—Reversed Spiral of Foot and Leg.

Before applying the bandage, wash and shave the limb and dust it with starch and boracic powder.

The roller bandage with reverses is the commonest of all the ways of bandaging. It may be applied to the trunk or limbs (as in *Figs.* 26 and 27), to fasten splints, and on an infinite number of other occasions. Nevertheless it is somewhat liable to slip, is not elastic, and is not suited for the neighbourhood of joints.

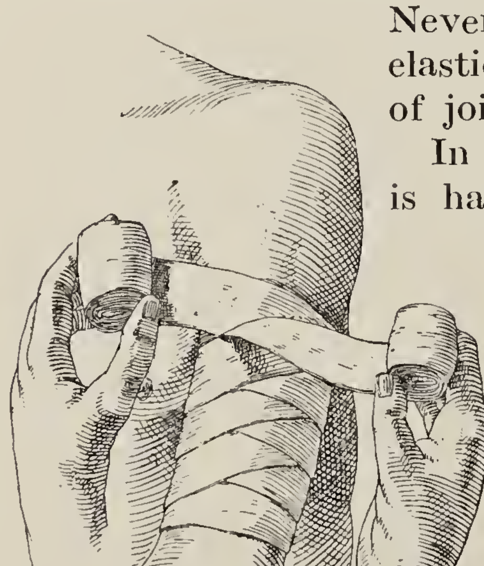


Fig. 28.—Double-headed Spiral with Reverses.

In its stead, a pattern of roller bandage which is hardly ever used in England might well be employed more frequently, namely, the **Double-headed Spiral with Reverses** (*Fig.* 28). Its description, like that of many other bandages, is more complex than its application. The bandage is a combination of a simple spiral roller with a reversed spiral, so that whilst one head of the roller is applied spirally, each of the turns thus made is covered and fixed by a reversed turn made with the other head. Inasmuch as even compression can always (other things being equal) be more efficiently made with a double-headed than with a single roller, the value of this pattern lies in the firmness with which it can be

applied to a limb, while it is nearly impossible for it to slip. The heads must, of course, be of unequal length, that used for the reverses being the longer. The pattern requires some practice to apply with ease, but the labour will be well spent.

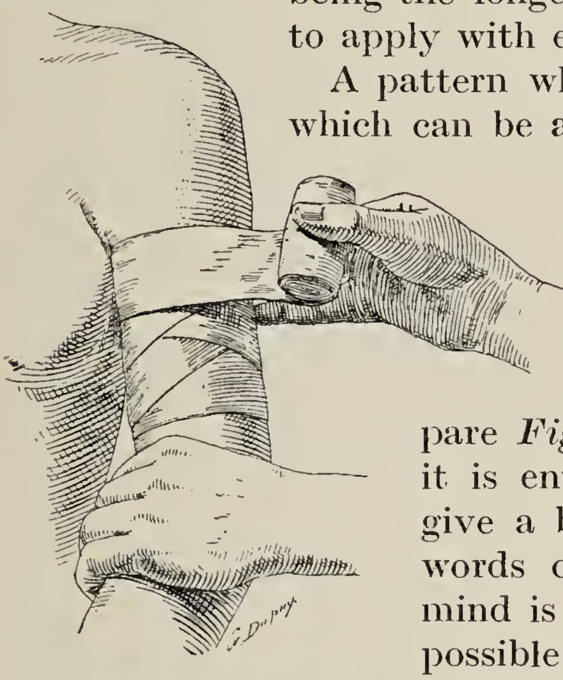


Fig. 29.—Application of the Figure of **8** Bandage to a Limb.

A pattern which is at once firm and elastic, and which can be applied over most articulations, is the **Figure of 8** (*Fig.* 29). This bandage, when applied to the length of the limb, or over a joint so as to cover it completely, presents much the same appearance when finished as the spiral roller with reverses (compare *Figs.* 27 and 29), but in its application it is entirely different. The illustration will give a better idea of its application than any words can do. The great point to bear in mind is to make the loops of the **8** as open as possible, by going boldly up the limb and coming down again as far as the bandage will allow.

As has been implied, this bandage may be employed in almost all the cases in which the turned bandage is generally used, and it is often really preferable, being not less firm and yet more elastic, but as a rule its employment is confined to the neighbourhood of joints, so that if a limb and a joint or joints have to be bandaged, say the ankle, leg, knee, and thigh, there would be a turn or two placed round the foot, then the ankle would have the figure of **8** (leaving the heel), the leg the turned (*see Fig.* 27), the knee the **8**, and finally the thigh the turned bandage again.

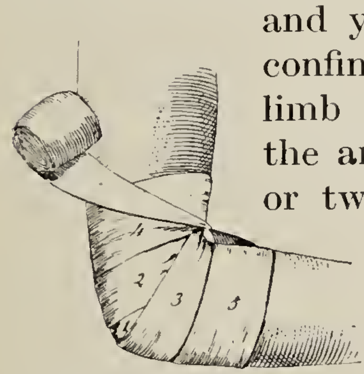


Fig. 30.—Figure of **8** for Bend of Elbow.

One practical reason for this changing is that the figure of **8** requires twice as much bandage to cover a limb as the turned spiral.

The **8** bandage is also used for *Joints* simply as one or two turns, crossing over the centre of the flexor aspect of the joint (*Figs.* 30, 31). This pattern is useful in a number of cases which need not be mentioned in detail.

The Point of the Heel and the *Point of the Elbow*, with their respective joints, may be completely covered by a series of enlarging figures of **8** starting from the centre, having the crossing placed over the front of the joint, and the loops above and below the line drawn from the middle of the front of the joint to the heel or the olecranon, and getting always more and more open, and further away from the middle line, as the

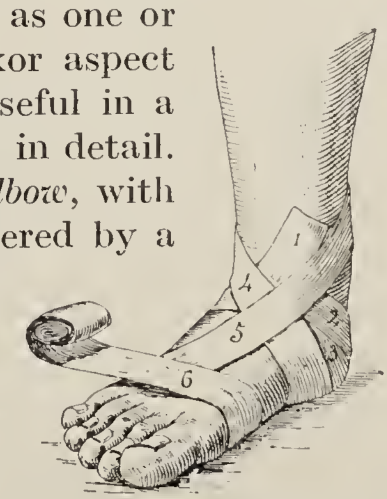


Fig. 31.—Bandage taking in the Heel.

bandage progresses. In this way the elbow may be conveniently bandaged. The heel pattern is nearly or quite the hardest one to adjust of all the common forms. It is very neat looking, but it is seldom worth the trouble of its application, save as an exercise in bandaging.

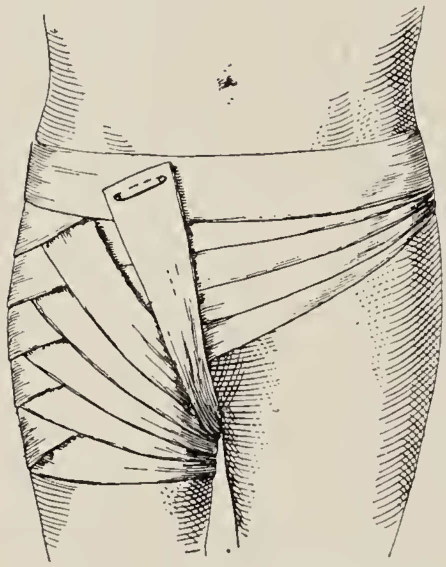


Fig. 32.—Spica of Groin.

The **Spica** (Spike or Spathe, a botanical term applied to heads of seeds arranged as in an ear of wheat) is extremely useful for applying firm pressure to joints, or fastening dressings over them. The pattern is the same, whether the bandage be applied to the shoulder, groin, thumb, or great toe, and is that of a figure of **8**, combined with a firm attachment to a limb in the neighbourhood of the joint—the wrist for the thumb, the arm for the shoulder, the thigh for the groin, and the ankle for the great toe. Taking the *Spica of the Groin* as an example (*Fig.* 32), the bandage begins by two or three reversed turns from within outwards (or overlapping **8**'s) round the top of the thigh. The bandage is then carried outwards over the groin to just below the anterior spine of the ilium, and then round the back, taking care to keep just below the iliac crest. The bandage is then brought obliquely across over the symphysis pubis, crossing over the starting-point to reach the outer part of the top of the thigh, and is then passed round it, and brought up ready to repeat the roll, but this time a little lower down, and so on till the groin and hip are sufficiently covered. The hip should be very slightly flexed at the time, and care must be taken not to slip on to the abdomen with the bandage as it is passed round the brim of the false pelvis.

Double Spica.—With a long bandage the spica may be easily enough applied to *both groins*, starting from one side and repeating every manœuvre on the other before returning (*Fig.* 33); but in practice this is a bandage very rarely used, and requires mention only.

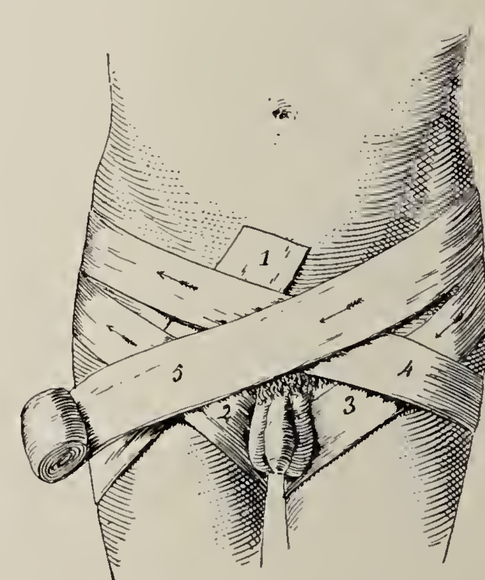


Fig. 33.—Double Spica.

The principle of the spica being understood, a detailed description of the various applications of the pattern will not be called for, and the special points only will be noticed. *The Spica of the Shoulder* is an extremely firm bandage (*Figs.* 34, 35); the starting-point is taken from the upper arm, the turns being rolled round as high as the axillary folds will allow. The bandage is then brought through the axilla, over the

shoulder and round the chest, passing under the opposite armpit, and the crossing of the first turn should go as high up upon the shoulder as the bandage will lie. This pattern requires a long bandage, and it may, as in the case of the groin spica, be doubled for both shoulders if required.

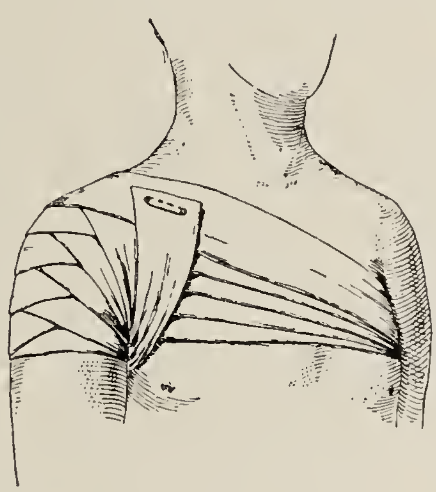


Fig. 34.—Spica of Shoulder.

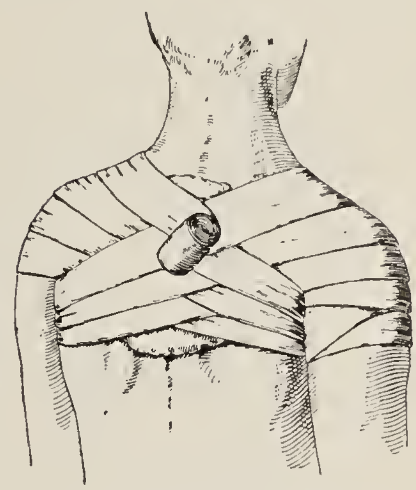


Fig. 35.—Double Spica (useful in fracture of clavicle).

The Spica of the Thumb (*Fig.* 36) is the regular bandage for the common sprain of that joint. As with the bandages for the digits, the roller ought to be quite narrow, not more than three-quarters of an inch wide. The spica is begun with a few turns round the wrist, from within outwards if the outside of the thumb is to be the most supported, and the reverse if the ball be the part requiring firmer pressure. It is then taken round the thumb as high as the bandage will lie, and the succeeding turns lower and lower (as in all spicas) till the ball is covered. It is then fastened round the wrist either by a safety pin, or by splitting the end of the bandage into two tails, which are tied together. *The Spica of the Big Toe* (*Fig.* 36) is applied in precisely the same way, the ankle standing in the place of the wrist. It is, however, more difficult to apply without getting an awkward quantity of bandage material between the toes.

The Fingers may sometimes be sufficiently covered with a simple spiral bandage, or with reverses or **8**'s, using a narrow bandage with neat edges, commencing at the tip, and finishing off at the root of the finger.

The *Bandage for a Stump* (*Figs.* 37, 38) is a pattern known as the **Recurrent Bandage.** The roller for this should never be more than two inches wide, and for an amputation of the arm, or for a 'Syme,' it may well be narrower still. The bandage is first attached three or four inches above the stump by one or two circular turns, and then, the thumb being placed over the middle of these turns in front and the forefinger similarly behind,

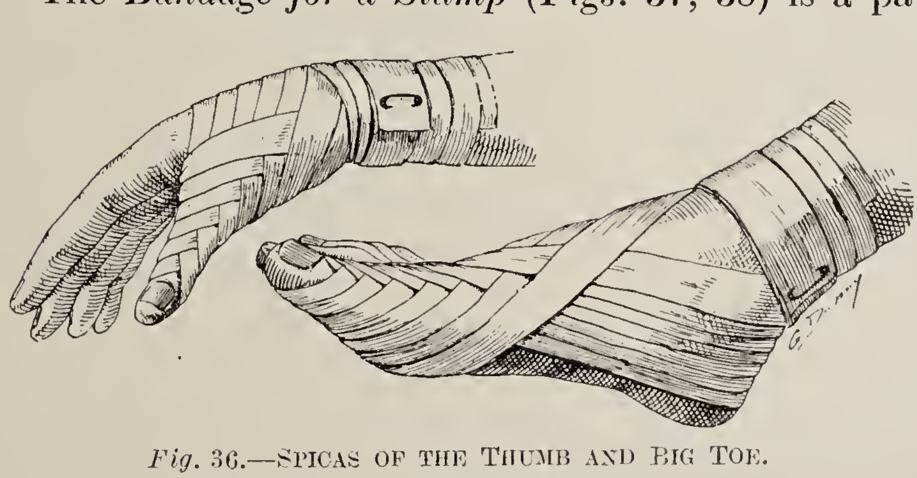


Fig. 36.—Spicas of the Thumb and Big Toe.

it is brought right over the face of the stump from the middle line in front to the same point behind. This reverse is kept in its place behind by the forefinger, and the bandage is brought back again, now a little to one side of the middle, but converging to that point when it reaches its starting-point. This is then fixed by the thumb, and the bandage is brought over again, passing this time to the other side of the middle line, and converging to it behind. These reverses are continued till the whole stump is covered, and then by one or two firm circular turns they are fixed in the position in which they were held by the thumb and finger, as shown (*Fig.* 38). It is often wise to make a circular turn or two in the course of making the reverses, so as to fix those already made. This pattern may also be put on so as to cover half or all the head, but to be secure the circular turns must be kept low down on the forehead and well below the occipital protuberance.

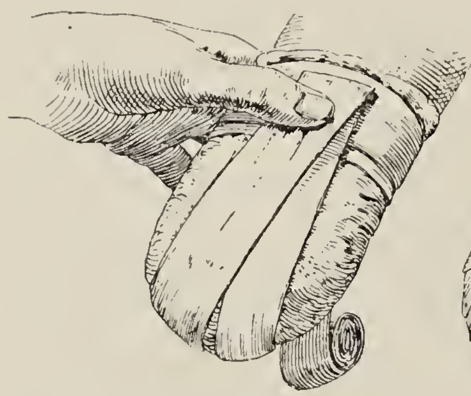


Fig. 37.—RECURRENT BANDAGE FOR STUMP.

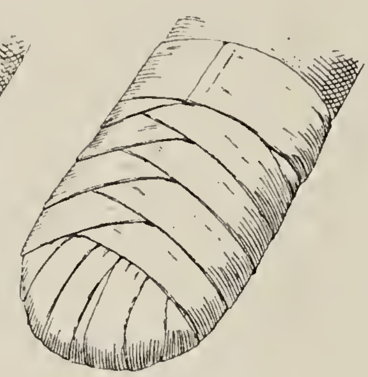
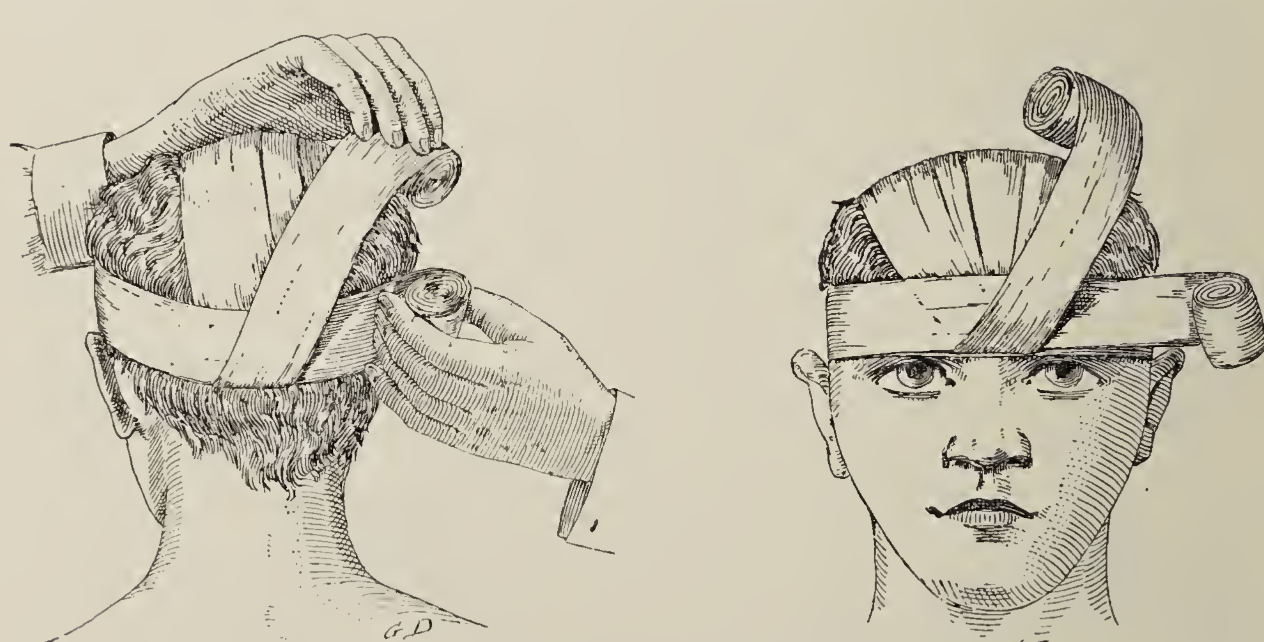


Fig. 38.—THE BANDAGE COMPLETE.

Amputation Stumps and also the *Head* may be bandaged by a method which, although it results in a pattern which looks like the



Figs. 39, 40.—DOUBLE-HEADED ROLLER, OR CAPELINE.

recurrent, is yet different in principle, and firmer—namely, by the use of a **Double-headed Roller,** i.e., a bandage both ends of which are rolled up towards each other in the centre. This is the bandage which when applied to the head is known as the **Capeline** (*Figs.* 39, 40). The application for a stump is the same in all respects. To

put on the capeline it is more convenient for the patient to be sitting. The surgeon standing behind takes one head of the roller in each hand, and places the middle of the bandage on the forehead. The two parts are then brought round and crossed below the occiput. One of the ends is then continued round, and the other, which is lying below it, is turned up and brought over the head as in the 'recurrent' bandage. It is now met by the other half of the bandage, which has passed round the head while this half has gone over it, and the former continued round fixes the bandage so that it can again be brought over the head, when the manœuvre is repeated. In this way, by adjusting the subsequent turns of the bandage alternately to one side and to the other of the first, which was in the middle, either half (*Fig.* 41) or the whole of the head may be covered with folds converging to the middle line in front and behind, and a somewhat attractive bandage is made. Its appearance is, however, almost its only good quality. It is firmer than the simple recurrent bandage, but is still liable to slip unless very carefully put on. It is troublesome to apply, hot, and if at all tight round the head, apt to become painful, while it fulfils few indications which cannot be at least as well met by the more homely, but far more comfortable, triangular bandage. When applied to a stump, however, it may sometimes be useful.

Fig. 41.—Capeline for Half the Head.

The **Twisted or Knotted Bandage** for the head (*Fig.* 42) is generally described as one which requires a double-headed roller, but this is not at all necessary or desirable. It is an extremely useful bandage, and is easy to apply. For example, taking the neighbourhood of the temple as the situation in which the pressure of the twist is required, the bandage should be unrolled for about a foot, and the end held in the right hand, which is kept close to the temple. The roller is then carried round the forehead and occiput, so that it comes back to the unrolled end at the wound. The roller is then twisted round sharply, as shown in the figure, and is carried down below the chin and round to the vertex. On coming to the temple

Fig. 42.—Twisted Bandage for Head.

again the same twist is made, and the roller is once more passed round horizontally; when sufficient pressure is obtained the bandage is fixed by knotting the two ends together.

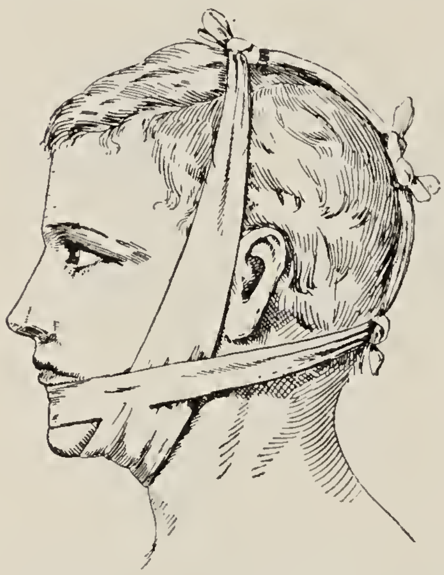


Fig. 43.—The Four-tailed Bandage applied.

In discussing the treatment of fractures of the lower jaw the **Four-tailed Bandage** will be again referred to, but it may properly be described here. It is a very useful pattern, and serves for the attachment of dressings in wounds about the chin or face, as well as for fractures. For the bandage a piece of shirting four or five inches wide and two feet long is required. It is then doubled on itself and torn down, until a piece four inches long only is left undivided in the middle. In the middle of this a slit two inches long is generally cut, in which the point of the chin is inserted, but this is sometimes omitted.

The middle of the undivided part is placed over the chin (*Fig.* 43), and the under pair of the four tails made by tearing the bandage are then brought up over the side of the face in a line with the masseter muscle, and loosely knotted or held half an inch in front of the vertex of the skull. These pass underneath the other pair, which are brought round to just above the occipital protuberance, and firmly tied together with a reef knot. The first pair on the vertex are then tied with sufficient firmness to fix the lower jaw against the upper one; and finally the vertical part is kept from slipping forwards, and the horizontal from slipping downwards, by tying the four tails together (as shown in the figure). In adjusting this bandage it is necessary to see that the length of the undivided part fits the jaw to which it has to be applied, and this can only be done by trying it on before it is finally fixed.

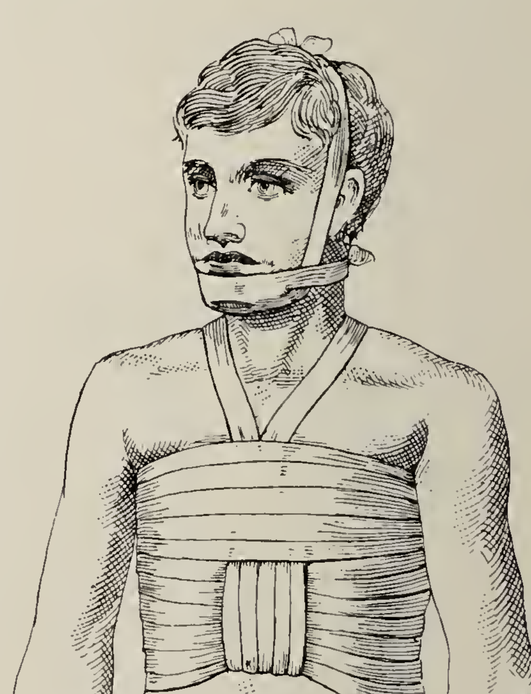


Fig. 44.—Bandage for Chest and Four-tailed Bandage to Jaw.

In *Bandaging the Chest* there is a tendency for the bandage to slip down on account of the decrease in size of the thorax from above down. This is best overcome by using a brace and bandaging from below upwards. A piece of bandage should be split in the centre and the head passed through the opening so that one end hangs down in front and the other behind (*Fig.* 44). The bandage

should be applied over this, being fixed by one or two turns round the chest, and then carried up with a reverse in each turn, thus overcoming the tendency to form an open spiral. Finally, the two ends of the brace should be brought up and fixed.

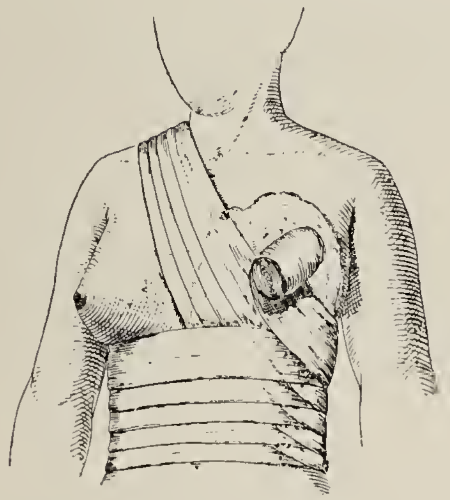


Fig. 45.—Breast Bandage.

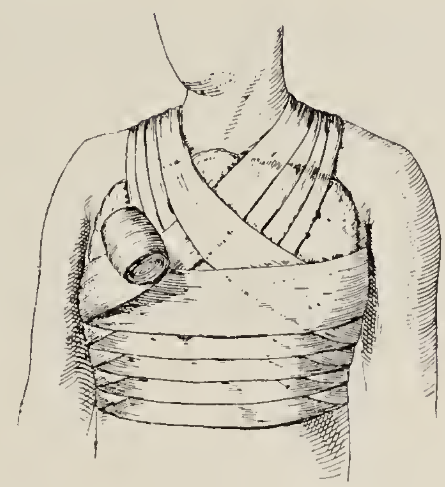


Fig. 46.—Applied to Both Breasts.

For *Bandaging the Breast* the roller is first fixed by a couple of turns round the chest, starting from and below the affected gland ; it is then carried upwards over the lower part of the breast and the opposite shoulder, descending across the back to the original starting-point, then horizontally round the chest. These turns are then repeated, each oblique turn being fixed by the succeeding horizontal one, and rising higher on the breast until it is covered. It is important always to bandage from the affected side. (*Figs.* 45, 46.)

The **Single T Bandage** (*Fig.* 47) is most frequently used for fixing dressings to the *perineum.* Its application there is simple enough. The horizontal part being fixed round the waist, the other end is brought round between the legs and fastened in front.

This bandage can also be applied to the head and elsewhere.

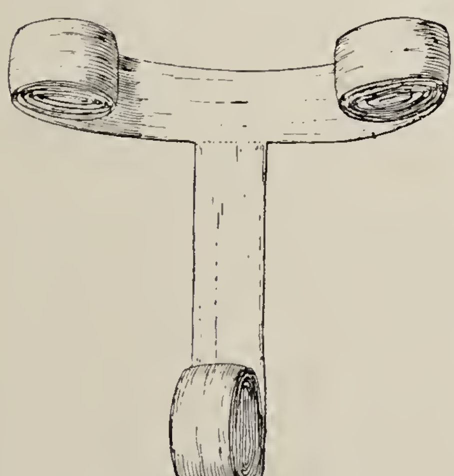


Fig. 47.—Single **T** Bandage.

For the perineum a good size is five feet for the horizontal piece and three feet for the vertical ; it should be about three inches wide. A better pattern for the perineum is the **Double T,** complete (*Fig.* 48) or incomplete (*Fig.* 49). The latter is made from the single one by tearing the perpendicular portion into two tails, except for five inches behind. By using either of these bandages the awkwardness of bringing up the single vertical piece in the middle line in the front is avoided.

This will be a fitting place to describe a perineal bandage which is very convenient for keeping dressings upon the *Pubes* and *Perineum* without the necessity of displacement for the performance of the natural functions.

The principle of its application can be easily understood from the following illustration (*Fig.* 50), and it is known as the **St. Andrew's Cross.**

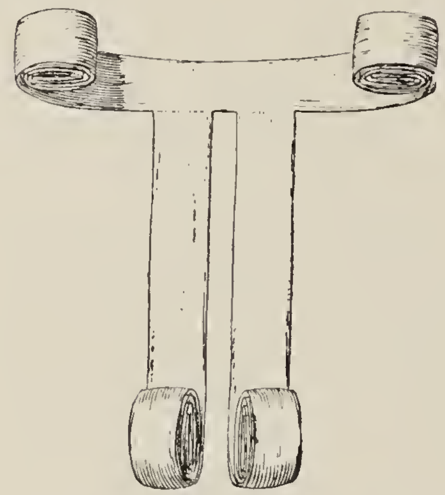


Fig. 48.—Double **T**, complete.

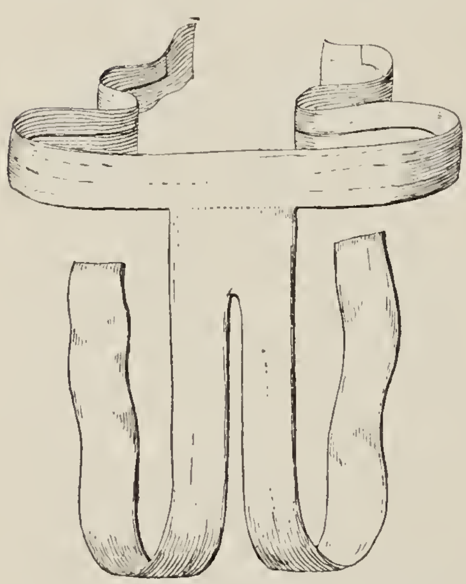


Fig. 49.—Double **T**, incomplete.

If, as in the illustration, the bandage is to be put on from the patient's right side to the left, from the front, or standing over him if he be lying down, the bandage is first fixed by a turn or two round the pelvis from right to left (1), then carried from the right anterior spine of the ilium diagonally downwards across the left groin (2), then around the left thigh, upwards between the thighs to the right spine (3), then around the pelvis posteriorly to the left spine, from which point it is carried down between the thighs (4), around the right buttock, and upwards across the right groin to the left spine (5), and around the pelvis to its starting-point at the right iliac spine : these turns are then repeated.

The **T** bandage is also a very good one to apply to the head to retain dressings. If used *for the Head* the vertical slips should be two feet long, and the horizontal one about a yard and a half, to allow of its going round the head twice or thrice. The width should be three-quarters of an inch. *For the Nose* a good bandage is the double **T**, or the single **T** with a slit in the vertical part of the requisite size partly to admit the nasal prominence ; while if, in addition, a slit be made in the middle of the horizontal part of either the single or double **T** for the mouth, it becomes a good bandage for the application of dressings *to the Lips*.

The single or double **T**, or a **T** with a small triangular piece inserted at the junction of the vertical and horizontal portions, makes a good bandage for the *Ear*, and other modifications may be easily imagined.

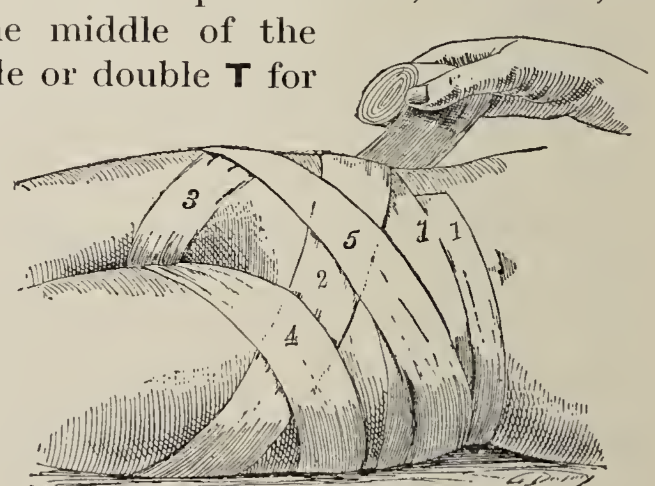


Fig. 50.—Bandage for the Perineum.

The **Many-tailed Binder** (*Fig.* 51) is a form of bandage frequently used in abdominal surgery, when security combined with easy application is desired. It consists

of a broad band of flannel, which should extend from the lower border of the thorax to the pubes. Each end is divided into a number of strips, which may be tied separately when the bandage

Fig. 51.—Many-tailed Binder.

is in position, or, better still, may be secured by a process of overlapping the strips in series from below upwards.

CHAPTER IX

OF ELASTIC BANDAGES AND TRUSSES

ELASTIC BANDAGES may be employed simply for support, or for some more definite object, as for promoting the absorption of fluid or the subduing of inflammation. It must be borne in mind that continued compression will surely bring about wasting, and if the circulation be interfered with, this wasting by absorption may be very great.

The Indiarubber Bandages, brought into notice by Martin, mark a distinct advance in the treatment of several morbid conditions, especially those due to impaired venous circulation, as *Varicose Eczema,* or *Ulcers of the Legs,* or of *Œdema* elsewhere. They are used also in the treatment of more active inflammatory swelling, and in the dressing of operation wounds, as, for example, after an excision of the breast when it is desirable to make a firm but gentle pressure upon the parts. These bandages are made of a special kind of rubber, and are of the lengths and widths of ordinary rollers. Before applying them the limbs should always be raised for some time. The hour of rising is, therefore, the best time to put them on. These bandages are put on in the same way as the common forms, but it is easier to apply them too tightly than the reverse, for they stretch so readily that the amount of compression actually exercised is apt to be underestimated. They should never be applied directly to a moist eczematous surface, or to an ulcer. Oil speedily rots them.

There are several varieties of **Woven Bandages** which are more or less elastic, and may be used for the purposes above mentioned fairly satisfactorily. All these may be applied as simple spirals without reverses.

The introduction of the **Crêpe Velpeau Elastic Bandage** has practically superseded the old elastic stocking or knee-cap. When a firm support is needed, as for a leg swollen with varicose veins or a joint distended with fluid, nothing is better than a well-applied crêpe Velpeau (*see* 'General Rules for Bandaging,' p. 72).

Of **Suspensory Bandages** there are several patterns in silk and cotton, and no directions as to their choice are necessary, further than that care should be taken that they fit, and that there is no chafing between the scrotum and the groins.

Although they are frequently worn by people who do not require them, they are useful in cases of simple laxity of the dartos tissues so common in hot weather, or in slight cases of varicocele. They should be worn in all cases where hydrocele is present, to prevent

the unpleasant dragging of the distended tunica vaginalis. They also certainly prevent the sac from filling as quickly as it otherwise would do.

Abdominal Belts.—In London, and probably elsewhere, a bad habit prevails among labouring men of wearing a broad webbing belt, stiffened with steel or whalebone, round the abdomen, with some hazy idea that they thereby save the muscles of the back. Of course, any result in this direction must be a weakening, by impeding free muscular play, but these belts are, in addition, very important agents in the causation of hernia by concentrating the outward pressure of the contents of the abdomen upon the weak places in its walls. Where, however, the abdominal walls are lax and pendulous, especially in fat women, a well-made abdominal belt is often necessary, and is far better than any form of stays. In fitting the belt, the points to be attended to are that it should be so applied that the line of support is *upwards*, and that some elastic material form a part of the belt, so that there is nowhere a rigid constriction. These belts should always be laced, and to prevent their slipping up, it is advisable to order a perineal band.

Trusses.—This will be a convenient place to speak of these very important surgical appliances, which every student should know how to measure for and apply ; for, while a well-fitting truss should in most cases absolutely remedy the inconveniences and dangers of a rupture, a badly-fitting or a badly adjusted one is a positive risk to the wearer.

Broadly speaking, a truss is a pad connected with a spring, by means of which an aperture or weak place in the abdominal walls or elsewhere is rendered as strong as the rest, or by which (as in cases of irreducible scrotal rupture) a portion of the contents which have protruded may be supported and guarded from injury.

Putting aside the question of *operative* interference, it may be said that every hernia of the intestines through any part of the abdominal walls calls for the support of a truss, however slight may be the protrusion ; but it does occasionally happen that great difficulties exist in the way of its application, through the hernia being complicated with a malposition of the testis.

Trusses may be divided into ordinary and special forms. The ordinary forms of trusses are the *Inguinal*, *Femoral*, and *Umbilical*, and the two former may be double or single. The special forms are *Scrotal*, *Obturator*, *Vaginal*, *etc.*

Fitting Inguinal, Inguino-scrotal, and Femoral Trusses. — To measure a patient for a truss, make him lie down on a couch ; pass a measuring tape round the buttocks two inches below the iliac crest, passing over the region of the hernia and making the tape meet at the centre of the symphysis pubis. The number of inches corresponds to the size of the truss, but it is usual to order a size slightly smaller, so that if the measurement is 35 inches, and the hernia a right inguinal,

one would order a right inguinal truss 34½ inches. But it is not sufficient for the surgeon to content himself with taking the measurement, and then to order a truss ; nor should he leave the question of the kind and strength of the instrument to a surgical mechanician. He should be able to state precisely the sort of truss required, and the best kind and shape of pad, and should, further, not only be able to recognize when a truss does not fit, but to know exactly where and in what the failure consists.

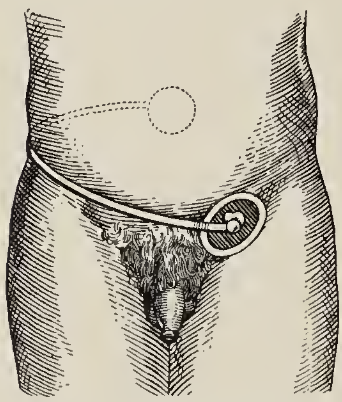


Fig. 52.—Single Truss (Salmon's).

There are very many varieties of trusses, differing from each other in the shape and substance of the pad, in the nature of the spring, in their covering material, and so on; but putting aside fantastic patterns, they will all be found to consist of a circular spring made of one piece of tempered steel, with a pad attached directly to it. In only one form in common use, the *Moc-main*, is the principle of the circular spring absent, and this kind is not recommended. The spring must be light and elastic, and of just sufficient strength to retain the rupture, neither allowing it to descend behind the pad, nor exercising such pressure as might serve to weaken the hernial aperture. The spring must further fit and *cling* round the pelvis just below the iliac crest and above the fleshy parts of the glutei, which, by their working, would move it up and down if it were in contact with them. It must especially fit flat to the base of the sacrum when the pad is in position against the rupture.

According to some patterns it here terminates in a flat pad (*Fig.* 52), in others the spring is continued round until two-thirds of the pelvis are encircled, as in *Fig.* 53 (we are speaking of single trusses only), but in either case the circle of the pelvis is almost always completed by a leather strap which comes round and is fastened to the upper of two studs which are found on the pad.

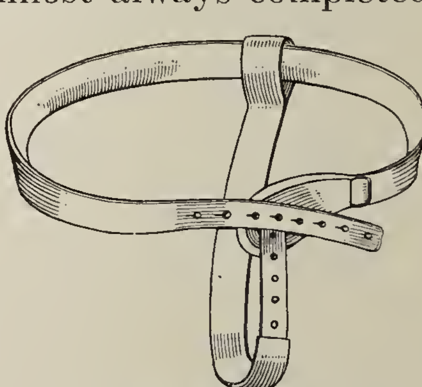


Fig. 53.—Ordinary Circular Spring Truss.

It will be seen, therefore, that the truss spring, though it be termed *Circular*, must never be a segment of a circle, but must consist of a combination of curves, different in different patients. A man with large muscular buttocks, with the glutei coming right up to the top of the crest, will require the spring to be more open round the ilium, and to take its bearing chiefly from the base of the sacrum, while in a spare person it should lie close up against the bone everywhere.

The *Strength* of the spring will vary according to the ease with which the rupture can be restrained, the presence or absence of habitual cough, and the occupation of the wearer. A city clerk will

not require one of the same strength as that suited for a porter or a navvy. Speaking generally, the spring must exert a sufficient, but only sufficient, pressure inwards when the wearer is at rest, but this pressure must quickly and greatly be increased with any increase of the outward pressure of the rupture.

Although the shape and strength of the spring must differ in different people, most cases will be found to fall into one of two or three types, so that an instrument maker who understands the principles of truss-fitting will not require to make one specially for every patient; but in all cases of difficulty or peculiarity the spring must be hammered up to the shape of the wearer previous to a final tempering. If any alteration be required it is easy to render the metal again sufficiently malleable to effect the change, and once more to stiffen it.

The *Pad* should be firmly attached to the spring, and its upper edge should be a continuation of the down-sloping line which the truss should take from the bend below the front iliac spine. The direction and shape of the rest of the pad vary according to the size of the aperture, and its position, i.e., whether it is inguinal or femoral, but it is generally pear-shaped, about two and a half inches long, and two inches wide. Upon its outer surface are two studs, the upper one for the attachment of the encircling strap, the lower one for the thigh strap. The inner surface of the pad should be nearly flat, and must in most cases be directed slightly upwards.

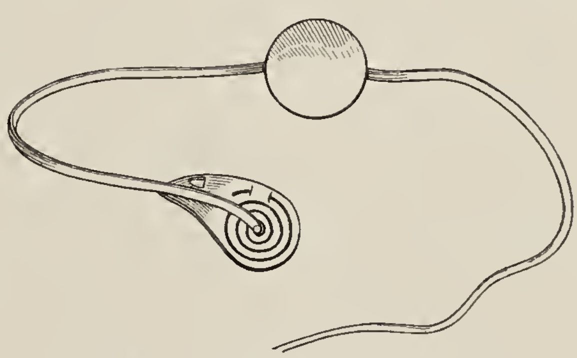


Fig. 54.—Coles's Truss, showing Spiral Pad.

There are a great number of pads in use, differing more or less from each other. For labouring men and hospital patients probably the best is a leather cushion well stuffed with hair. Coles's trusses have a coiled spring within a metal shield which yields to the movements of the wearer, and itself exerting pressure enables the truss spring to be very light; it is a very good pattern both of truss and pad (*Fig.* 54). Other pads again are made of solid indiarubber, cork, or wood, or of indiarubber inflated (air pads) or filled with glycerin.

The truss generally, but especially the pad, should be *easily kept clean*, and must not absorb the sweat. In warm weather, adults as well as children will find starch, violet powder, or fuller's earth very useful applications for the skin. Another good plan is to have a set of cotton covers made to slip over the pad, which can be changed and washed as often as may be required.

The *Thigh Strap*, an important part of the truss, is intended to prevent the pad slipping up when the wearer is moving. It should be fastened round the spring just behind the bend of the 'shoulder' (i.e., below the front of the iliac crest), and running in the fold of the buttock come up in front through the fork and be attached to the

lower of the two studs on the pad, as before mentioned. It should be adjusted so as to be just felt to be tight when the wearer is standing upright.

The special points to pay attention to in connection with trusses for *Inguinal* and *Inguino-scrotal Herniæ* are, to see that the pad presses over the internal abdominal ring and over the canal, as far as, but not beyond, the external ring, and that the surface of the pad directly opposes that of the protrusion, which in different cases will vary, but will generally be downwards and inwards. Under no circumstances should the pad ever touch the pubes, and if for any reason it has to extend over that bone it must be fashioned with an indentation to avoid contact.

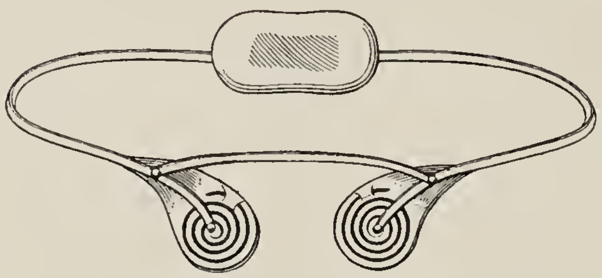


Fig. 55.—Coles's Double Truss.

In trusses for *Femoral Herniæ* the chief characteristic is in the direction of the pad ; instead of being directed obliquely downwards and inwards, it falls almost vertically, so as to lie along the femoral canal ; the encircling spring also should fall more decidedly from the 'shoulder' below the iliac spine. The top stud, for the attachment of the belt which completes the circle of the spring, must be placed quite at the top of the pad, or upon the spring itself, and the thigh-piece must have its stud at the bottom of the pad, so as to keep the latter well down ; it must not press on the femoral vein.

It was formerly not an uncommon practice for *Double Trusses* to be worn for single herniæ, with the notion that the development of a possible second hernia was thereby prevented. The practice is a bad one, for pressure where it is not required only weakens the part by absorption. If symptoms of hernia, however, are present on both sides, the principles of the application of a double truss are the same as those we have just stated, but the spring will now run round from one pad to the other, and the two will be connected by a small cross-strap (*Fig.* 55). Two thigh-straps will be required, one for each side.

Trusses must be worn continuously during the day (unless the patient be lying down) and taken off only on getting into bed. In cases of chronic cough it may be advisable to wear the truss day and night, and in this case it should be taken off morning and evening and the skin powdered.

Fig. 56.—Rat-tailed Truss for Scrotal Rupture.

In cases of rupture where the hernia is very large, and descends through a large aperture into the *Scrotum*, a truss with a specially-made supporting pad will have to be employed (*Fig.* 56). The exact

shape and direction of the pad will vary in each case, and the truss has to be made much stronger than for ordinary ruptures. Further, it will often be found that the rupture is not returnable, in part or altogether; it is then termed irreducible, and a cup-shaped pad must be fashioned for its support.

If a hernia is very voluminous and irreducible, a hinged cup-truss or a strong bag must be fitted so as to support it. A good deal of ingenuity is required in fitting a support on a large scrotal rupture which, while keeping the hernia back or affording it sufficient support, shall not chafe the skin or exert undue pressure. We are considering only those cases where, for some serious reason, an operation is contra-indicated—for in all favourable cases an irreducible hernia should be subjected to operation, as it is a potential cause of strangulation.

The question of fitting trusses *on very Young Infants* is often a difficult one to decide. Undoubtedly some infants badly ruptured are too weakly to bear even the moderate pressure of a truss, but we believe that if the instrument be light, and properly fitting, this will very rarely be the case, and it should be borne in mind that in infants a good truss is a means of cure. At no age is a truss contra-indicated, though undoubtedly in newly-born children great care will have to be taken to prevent chafing, in consequence of their incontinent habits. The trusses for infants should either be of the Coles or some similar light pattern, covered all over with indiarubber, or of a kind which has been recently introduced, in which a flexible indiarubber *belt* (no spring) goes round the pelvis, and is connected with an air pad, of which there are different shapes.

It has just been stated that many cases of infantile hernia get well of themselves, and that others will get well under spring trusses, or mechanical trusses of other kinds. There is no surgeon of any experience of these cases who does not know that if infantile ruptures are continuously retained completely within the abdomen they will get well, and that very quickly, whatever form of truss is adopted—unless some persistent cause exists which favours the descent of the hernia, such as whooping-cough, phimosis, calculus, or prolapsus ani.

But mechanical trusses have undoubted drawbacks in the quickness with which, by the rapidity of infantile growth, they are rendered inefficient; in the difficulty with which they can be kept clean; their liability, if spring trusses, to break; and the ease with which the tender skin becomes sore from their use.

Two great *Predisposing Causes of Rupture in Infants* may here be mentioned. One is the foolish habit of sewing a tight abdominal 'binder' round the unfortunate baby; the other is the frequent occurrence of phimosis. It will often be found that a rupture will undergo spontaneous cure after circumcision, and although on this account the application of the truss should not be postponed, still

the operation, always advisable in phimosis or when the foreskin is long, becomes the more urgent when the child is also ruptured.

Though it may seem superfluous, it will be found not infrequently necessary to caution mothers against putting on a truss over the neck of a rupture when it is down, instead of returning it first.

Umbilical Hernia in Infants is extremely common; in children it is less often met with, and in adults, especially in corpulent women, it is not infrequent. In the latter, however, it is more common to find the bowel coming through a little to one side of the true umbilicus.

In Children this condition can usually be cured readily enough by retaining the edges of the opening in contact by strapping. A long strip, two inches wide, is prepared, and one end is fastened to the skin of the left loin as far back as the spinous process of the vertebra. With the fingers of the left hand the edges of the opening are pinched together, and retained by the strapping, which is brought across the opening and fastened to the skin of the right loin.

Umbilical Hernia in Adults should always be supported by a truss, for though the aperture is generally large, it is as liable as others to *become strangulated*, and the mortality after herniotomy for this condition is very high.

An unusual form of hernia may be mentioned, requiring a truss of a different kind—namely, the protrusion into the vagina of the *Walls of the Vesico-vaginal Pouch*. In this hernia there is generally no definite sac; it occurs in childhood, and tends generally to get well of itself; but if support be required it must be given, as in prolapsus ani, by a pad in the vagina, attached behind to a perineal strap fastened to the middle of a belt, and ending in two straps in front which pass along the folds of the groins on either side to opposite the iliac spines.

When an **Undescended Testis** has never entered the inguinal canal at all, nothing requires to be done, but when, as often happens, it lies in the course of the canal, it will there be very liable to injury and consequent inflammation, unless some hollowed pad be placed over it for its protection. This, though not a truss proper, is fashioned like one, and will have to be specially made.

In adult cases the testis usually remains within the abdominal cavity, but sometimes becomes engaged in the internal ring, giving rise to pain, or the more acute symptoms of strangulation. In these cases it is generally advisable to treat this descent of the testis as an ordinary inguinal hernia, and to keep it up with a truss out of harm's way, but it will be wise to remove the organ if the irritation persists.

In certain cases of undescended testis where the gland lies outside the external abdominal ring, but is liable to be withdrawn into the inguinal canal and cannot descend fully into the scrotum, a Woods truss with an opening to allow the testicular vessels to remain free from pressure may be used. It is said that by the application of this

truss the structures in the cord are gradually lengthened until the organ can be properly retained in the scrotum.

In the female, too, **Hernia of the Ovary** into the neighbourhood of one of the labia, not uncommon in childhood, requires a light inguinal truss, which almost invariably effects a cure.

The rarer kinds of hernia, such as the **Obturator,** the **Ventral,** the **Lumbar,** etc., cannot usefully be considered fully here. They will generally be treated by trusses or belts of special form, but made on the same principles as those for more common ruptures. The first two kinds are well known, but rare ; the third, the *Lumbar* hernia, or protrusion of abdominal contents through the loins, is very rare, and may be best treated by a belt, though the question of operation should be considered.

Finally, it may be mentioned that in cases of *Spina Bifida*, or *Meningocele*, which are indeed herniæ, some form of truss, or of support and compress combined, is sometimes indicated.

CHAPTER X

OF THE USE OF ADHESIVE STRAPPING

THE use of adhesive strapping in surgical dressing for the purposes of mechanical support is steadily increasing, and the number of medicated plasters is being almost daily added to. Of these latter very little need be said, for, with few exceptions, their value is still undecided. One or two, however, are certainly of great service in appropriate cases.

The ordinary **Adhesive Strapping**, the diachylon or lead plaster (*emplastrum plumbi*), is the form which is still in most general use, and unless otherwise mentioned must be understood to be the material employed. It is sometimes spread on paper, when it is almost useless, but is generally laid on linens of varying fineness. No good purpose is served by using a fine linen, and the best strapping for all ordinary occasions is what is known as 'Leslie's Hospital quality,' sold in rolls eight inches wide.

Other kinds of plaster are often spread upon *Chamois Leather*, or on *White Basil*, and, as will be mentioned directly, *Leather* may be employed when pressure is required, as in strapping an inflamed joint, by reason of its stretching powers. A very useful form of strapping, the basis of which is india-rubber, has been introduced, namely, Seabury & Johnson's **Rubber Adhesive Plaster.** Its advantage is that no heating is required, the adhesive surface being protected by a layer of coarse muslin until it is used.

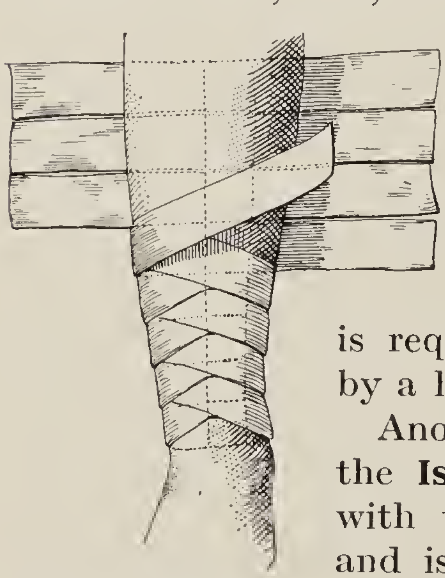


Fig. 57 —STRAPPING APPLIED TO A LIMB.

Another very good kind, for small surfaces, is the **Isinglass Plaster,** made by painting thin silk with that material. It requires wetting only, and is very cleanly.

For clean-cut wounds about the face, and in other cases where great nicety is required, **Court Plaster** or **Gold-beater's Skin** (a thin film of collodion) is used.

No detailed description is required of the ways in which strapping may be cut into strips, and used to fasten splints or dressings. The oft-reiterated warning must be repeated that if unyielding strapping is applied to encircle a limb, strangulation of the parts may result and serious complications arise. Such a disaster may even occur if the plaster be spread on any kind of leather, though this, for

economical reasons, will not often be used ; and it may be taken as a rule to be followed almost invariably, that strapping should be put on either spirally, or obliquely, so as to form the half of an **8**.

If strapping is to be applied round a limb, it should be cut in strips and put on so as to secure an even, steady pull from both ends (*Fig.* 57) ; otherwise the skin may be painfully wrinkled. It should always be thoroughly warmed first, for which purpose cylindrical hot-water tins are generally used, or some gas apparatus. Sometimes strapping is softened by dipping it for a moment in very hot water ; this makes it more pliable, and not much less adhesive.

When the strapping is required to *adjust accurately* or support the edges of wounds, amputation flaps, or the like, the strips should never be stuck first on one side and then pulled over to the other, or 'cockling' will certainly occur, but should be cut in pairs, and applied as in *Fig.* 58, or on some similar plan. One strip is placed on one side of the wound and the other on the other ; the middle parts are slipped the one within the other, and then an even regular pull can be made simultaneously on both sides.

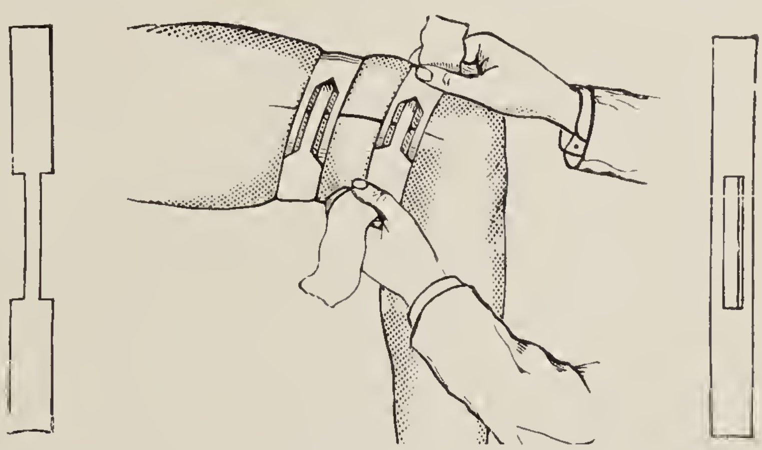


Fig. 58.—Strapping applied to close a Wound accurately.

Some Special Cases in which strapping is a common plan of treatment will be shortly described here.

The case of **Fractured Ribs** will be again referred to. Not only in fracture, but where the thoracic walls have been badly bruised, it is often desirable to place them as completely at rest as possible. This may be done very effectually by strapping them as if they had actually been broken. (*See* 'Fracture of the Ribs.')

Enlarged Phalangeal Joints may often be strapped with common plaster or with the iodine strapping to be hereafter mentioned. The method of doing this is the same as for the larger joints, and does not require a separate description.

The Wrist, either for simple sprain or for the common tenosynovitis of the extensors of the thumb lying over it, may be strapped with strips of linen or leather plaster, applied in the same manner as for the knee (*Fig.* 59).

Every dresser should know how to strap the **Knee-joint** efficiently, for it is one of the principal methods for the treatment of chronic derangement of this articulation. The usual plan is to apply strips of the plaster, overlapping each other, from below upwards in half loops of **8**, until the whole joint is covered. This may be done well with the plaster spread on the linen or holland, if care be exercised.

Provided the adhesive material be well spread and well warmed, it will be found quite easy to envelop the whole joint firmly with one piece. It should be oblong, and large enough to go round the knee and overlap about one inch, and should be from ten to fourteen inches long. After warming it well, the centre of the strapping must be very evenly applied to the skin in the popliteal space; one-half of it must then be drawn over the inside and front of the knee, with force enough to produce the pressure required; the other half is then brought quickly and firmly over the other side. If the strapping has been properly warmed, it will reach so as to overlap for nearly three inches, and the plaster will be applied so closely to the skin that it will follow every wrinkle in it when the knee is flexed, and yet a firm, even compression will be attained.

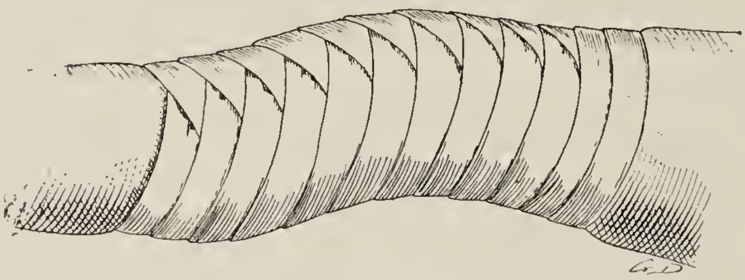


Fig. 59.—Knee Strapped (ordinary way).

The **Ankle,** likewise, may be strapped by narrow strips of linen, the middle being applied to the sole of the foot, and the two ends brought up and crossed in a figure of **8** over the front of the foot, and round the malleoli. (*See* 'Sprains.')

For an **Enlarged or Inflamed Breast** long strips of adhesive or diachylon strapping may be usefully employed to support and, to a moderate extent, compress it. The centre of the strips must be placed below and the ends crossed above, working from below upwards, the breast being thus supported by the overlapping plaster. But, as a general rule, this kind of support can be more easily and comfortably maintained by the use of Martin's rubber bandage.

An **Enlarged Testis** is difficult to strap efficiently, unless the organ be very large. The art, however, must be acquired, as the compression thus produced is a most valuable method of treatment in cases of inflammatory exudation. The look of a properly strapped testis may be gathered from *Fig.* 60, but it is always difficult to make a neat job of it. First of all, the parts having been shaved, the testis must be fixed down in the scrotum by a long strip passed round and round its upper part. The body of the gland may then be compressed by overlapping strips put on circularly, i.e., horizontally, from below upwards, or vertically, to produce the same appearance as in the recurrent bandage for a stump, or with a combination of these two ways. In truth, nobody ever straps

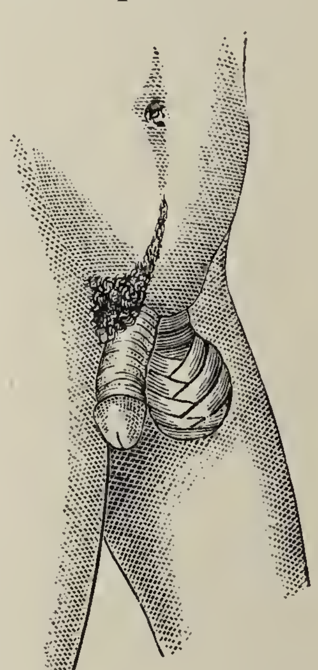


Fig. 60.—Enlarged Testicle Strapped.

two testes in the same way or obeys any fixed rules, so long as the compression is attained. Another good way of applying even compression to an enlarged testis is to envelop the gland in a layer of cotton-wool, and then to stretch over this a square piece of thin indiarubber sheeting (the best is that used by dentists, but that similar to Martin's bandage material will do), securing it at the top by slipping on an indiarubber ring.

Medicated Plasters.—It has been assumed so far that the strapping has been employed simply for the purpose of mechanical support, or of compression. But frequently the adhesive material possesses in itself (or is applied over ointment possessing) medicinal properties. As examples of these special plasters, the *Emplastrum belladonnæ, E. opii*, and *E. mentholis* are frequently used for their anodyne properties ; the *E. hydrargyri*, or *hydrarg. c. ammoniaco*, and *E. potassii iodidi* for promoting absorption.

As a stimulant, the *E. picis* (poor man's plaster) is supposed to have merits, as to which we may be allowed to be a little sceptical, while the use of the milder cantharides plaster, *E. calefaciens*, as well as the *E. cantharidis*, is obvious.

Of the anodyne preparations, the *Belladonna Plaster* is most frequently used for the purpose of allaying pain in the breast, and for arresting the lacteal secretion, but it is a good anodyne for general use.

For strapping joints, etc., the *E. hydrarg. c. ammoniaco* will be found on the whole to be the most useful. Another extremely useful strapping is the iodine plaster, but it loses its activity on keeping, and so should be freshly prepared and kept in a tin case.

One of the most effective modes of treatment of *enlarged joints, inflammatory bursal enlargements, chronic orchitis*, etc., is to cover strips of lint with some absorptive ointment, lay them over the part, and then strap it up firmly with soap or lead plaster. The ointments most commonly used are the various mercurial ones, all the *Iodine, Iodide of Lead*, and *Iodide of Potassium* preparations, but especially the *Camphorated Mercurial Ointment*, the well-known *Scott's Dressing*.* The strapping, with the ointment beneath it, should be left on until the latter is absorbed, or until the parts below have shrunk so as to make it loose ; it may then be re-applied if necessary.

When strapping has been applied to any part of the skin which is hairy, its removal is always painful, sometimes very much so, unless the adhesive material be softened. This may be done with very hot water, but a better way is to soak a pledget of lint in spirits of turpentine, and to soften and dissolve the plaster from the hairs as the strapping is turned gradually back.

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* So called from the name of the surgeon who introduced it. It is composed of Mercury ointment, 6 ; Yellow wax, 3 ; Olive oil, 3 (by weight) ; Camphor, $1\frac{1}{2}$.

CHAPTER XI

OF SPLINTS—CONSIDERED GENERALLY

DEFINITION.—A splint is a contrivance or apparatus possessing absolute or relative rigidity, which when attached to some part of the body increases its natural stiffness, or remedies undue mobility caused by disease or injury.

It will be seen, therefore, that the subject of the application of splints is a very wide one, and even a simple list of the various arrangements devised by surgeons from time to time to fulfil the requirements of disease or injury would be a catalogue as long as it would be useless and wearisome. We propose, in the first place, to give only a general description of the principal methods of splinting, and of the common forms of splints, postponing a more exact account of many of them until the various fractures and injuries which require their employment come to be discussed.

Natural Splints.—In many parts of the body, an *uninjured bone* in the neighbourhood of one that is broken will often serve to keep the fragments of the latter in their place, and in other parts the attachments of ligaments will serve the same purpose. Thus, in fractures of the fibula, the tibia, if unbroken, will make a very efficient splint for it. The same may be said of the ribs, where the muscles and ligaments, which form, with them, the cage of the thorax, very often prevent serious displacement. A fractured lower jaw, again, may often be kept in good position by keeping the fragments close against the upper jaw ; and many other instances might be adduced.

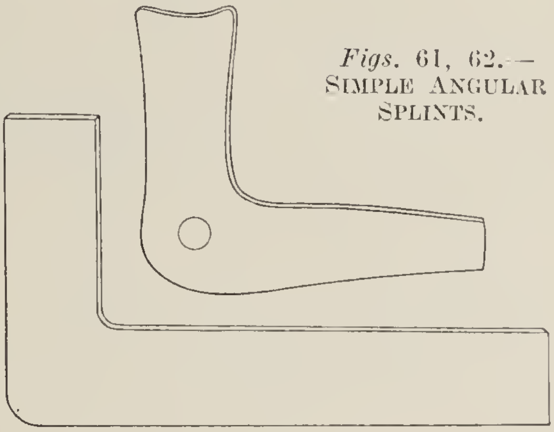
Improvised Splints.—There is hardly a limit to the number of the materials which may be pressed into the service of the surgeon to form temporary splints in cases of fracture or of some other injury.

The usefulness of cardboard, book-covers, newspapers, firewood, and many other things familiar in daily life, will be mentioned in this connection under the heading of 'Immediate Treatment of Fractures.' But the list is only limited by the ingenuity of the surgeon concerned. It will be convenient here to give a short classification of the splints and splint materials which are recognized as belonging to the surgical armament.

Surgical Splints may be divided into those of some *fixed form and shape*, and of some rigid material, as wood or iron, to which the trunk or limbs may be attached by bandages or strapping ; and those which are capable of being *moulded* to injured or diseased parts, to give them the needful support or else to remedy deformity. All of these latter possess the property of being soft when applied, and then of setting or hardening.

RIGID SPLINTS.

These are for the most part of wood or iron, though other materials, such as vulcanite, etc., are sometimes used. They may be subdivided into those of a simple and those of a complicated form.



Figs. 61, 62.—SIMPLE ANGULAR SPLINTS.

Plain Wooden Splints are the simplest of all, and will need little description. In most cases they are simply pieces of white pine of various lengths and breadths, planed, and with their edges rounded off. They are used for fractures of the limbs, or to prevent flexion of joints, as in the common 'patella splint,' etc. Not infrequently they are made of strips of wood lined with canvas, on the plan of the kettle-holder or Gooch's splinting to be presently mentioned, and other materials, such as rattan and cane, have been used from time to time. The pistol-shaped splint, again, is an example of a simple wooden splint, while others, such as Liston's, will be described in relation to the conditions they are devised to remedy.

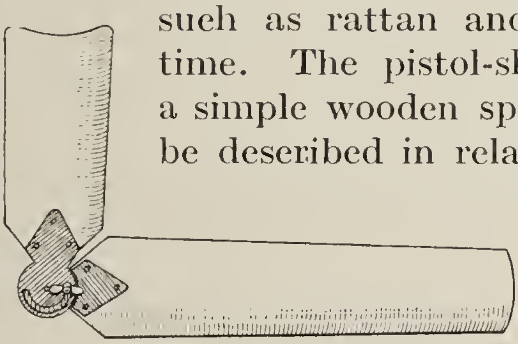
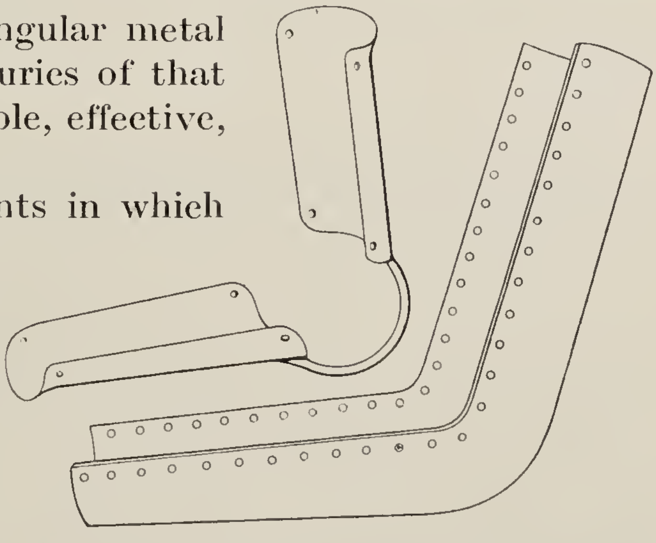


Fig. 63.—WOODEN ANGULAR SPLINT WITH HINGE.

Angular Splints (*Figs.* 61 to 65), with or without a hinge at the elbow, are very useful in various injuries of the arm, and, like other forms of wooden apparatus (e.g., the back splint for the knee), are far more comfortable if they are somewhat hollowed out, a proceeding which adds but little to their expense.

Figs. 64 and 65 illustrate angular metal elbow splints for compound injuries of that articulation; they are very simple, effective, and cheap.

Of the more complicated splints in which wood is the principal material employed, the chief are Bryant's for excision of the hip or fracture of the thigh, splints for the treatment of genu valgum, for fractured patella, and the double inclined plane; these and others will be noticed in their places.

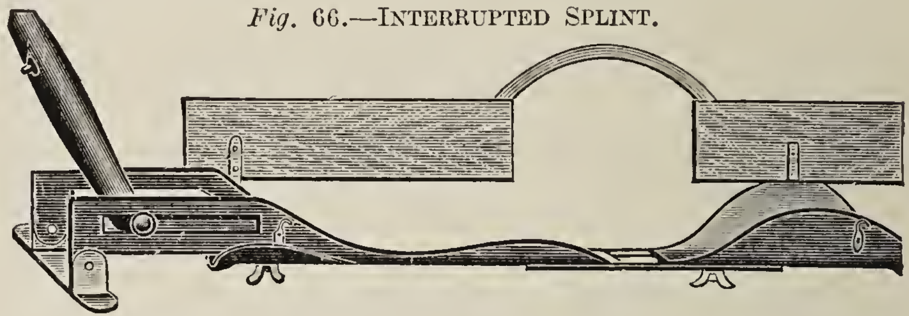


Figs. 64, 65.—ANGULAR METAL ELBOW SPLINTS.

Interrupted Splints.—It is often necessary, in cases of compound fracture or after excision of joints, where we must be able to get

at a wound, which therefore must not be covered by the splint, to make an *Interruption*, as it is termed, and although this is done in iron as well as in wooden splints, it is far more easy in the latter. In making such a splint, it is best to choose one as if the necessity for the interruption did not exist, and then to saw away the parts required to be removed *after* having fastened on the iron supports.

Fig. 66.—Interrupted Splint.



Iron Splints may be simple or complicated: as examples may be mentioned the common angular elbow splint, generally having a hinge at the elbow; the simple back splint for the leg and thigh with foot-piece (*Fig.* 67), commonly used for fractures of the leg, generally called Neville's splint; and the different patterns of that very useful splint, M'Intyre's, modified by Liston (*Fig.* 68), which consists of a movable foot-piece, and leg- and thigh-pieces with a joint between them and with some mechanical arrangement of screws or rack and pinion to alter the angle at the knee; it can be adjusted for limbs of different lengths by means of the movable foot-piece.

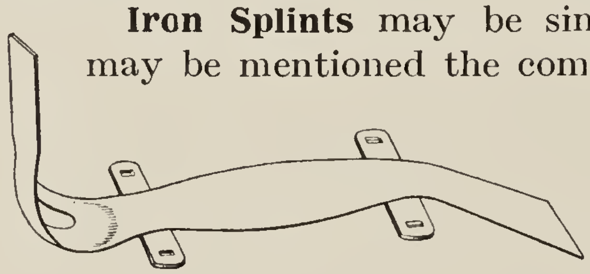


Fig. 67.—Iron Back Splint. (Neville.)

Fig. 68.—M'Intyre's Splint.

All splints for fractures of the leg should be furnished with cross-pieces, as shown in *Fig.* 69, to enable the limb to be swung from the cradle.

It is as well to say here that splinting has been much simplified since the introduction of the Thomas's splint and the more general use of plaster. It is a rarity to see the interrupted splint (*Fig.* 66), the use of which is now practically superseded by the Thomas, and even such old and favourite splints as the Neville and M'Intyre are seldom used. Simple fractures of the leg (tibia or

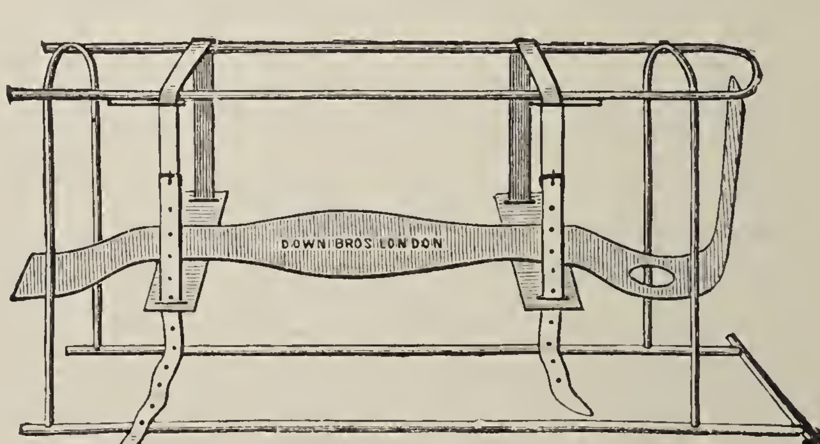


Fig. 69.—Splint Slung in Cradle.

tibia and fibula), if they can be reduced satisfactorily, are put up in plaster at once, and plaster is now the universal treatment for a Pott's fracture unless injury to the tissues makes its use temporarily inadvisable. There is a decided movement on the Continent for extension treatment by mechanical traction, but this method is not yet widely adopted in this country, and, in any case, would come under the care of the visiting surgeon rather than of the house staff.

There are numerous patterns of splints used after excision of the wrist, elbow, and knee, of which examples are given in *Figs.* 66, 67. The Thomas and Hodgen splints, described later, are further examples of iron splints.

Flexible Splints.—Splints are also made of tin or some other flexible metal which can be readily bent into any required shape. These are often used in the treatment of talipes (q.v.).

'Kettle-holder' or Gooch's splinting is made by attaching long thin strips of wood to canvas or leather with strong glue. It is made in large sheets, and splints of different patterns can be cut or sawn out of it. Its great merit lies in the fact that it is flexible in one direction and rigid in the other. It is especially used for fashioning splints needed in order to partially encircle a limb, as in fractures of the arm, or in combination with a back splint in broken thighs.

Padding Splints.—Many splints, before they are applied, must be padded to avoid injury of the softer parts. This may be done in several ways, and with different materials. Of all paddings, however, the most elastic and convenient is *Tow*, well teased so that the fibres lie all one way, and with no lumps in it. Soft linen, such as old napkins, makes the best covering for the tow.

For the simple forms of splints, the pads should be made like miniature pillows, and either sewn on with a lace stitch at the back, which is best, or fastened—but as a makeshift only—with bands of strapping very smoothly applied (*Fig.* 70). Pads should always be complete cushions, not layers of tow laid upon the splint and covered.

Next to tow as a stuffing comes *Cocoanut Fibre*, and last of all *Cotton-wool*, which is very apt to work into hard lumps. Very good but extravagant pads may be made of several *Folds of Lint*.

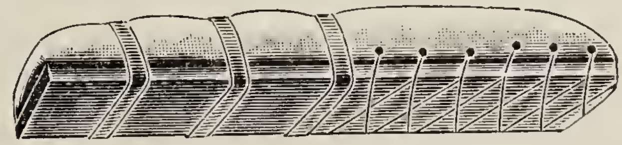


Fig. 70.—Pad, sewn or strapped upon a Splint.

In all cases where moist dressings or the discharge from wounds can possibly soil the pads, they should be covered with some form of *Oiled Silk* or with *Guttapercha Tissue*. The former must be sewn on ; but the best way of fastening the latter is to moisten the edges with a piece of lint dipped in chloroform, when they will readily adhere.

Iron Splints are usually perforated for the sewing on of the pads, but if not they must be managed like the wooden ones. Before padding them it should be seen that the metal is not exposed by the wearing off of the lacquer, or the cover will be iron-moulded.

In *Jointed Splints* the pads should be made separately for each part, and special pains must be taken to have them very smooth and of the proper thickness where they have to protect prominences of bone, such as the trochanters or malleoli. This is particularly true of the heel, under which the pad should be firm and rather thin, while the tendo Achillis immediately above it should be well supported with a thicker pad. A 'sore heel' is a surgical disgrace to the dresser of a fractured leg or thigh.

Too much pains cannot be taken to select perfectly fitting splints and such as are in good condition. They should, in almost all cases, be a little wider than the limb for which they are chosen ; if this be attended to, partial strangulation through their being put on too tight is almost impossible.

Attachment of Splints.—With regard to the various methods of attachment of splints, we need only mention here, that strapping, bandages, and buckled straps of webbing are the chief agents employed ; any one or all combined may be found most suitable, in each particular case. In bandaging, the same rules apply as have already been given ; but whatever way of attachment is selected, it should if possible be so managed that the limb can be examined from time to time without disturbing the whole apparatus, and in the case of the extremities the fingers or toes should be easily got at, in order that the condition of the circulation may be noted. Lastly, complaints of pain, or even of discomfort, in parts which are covered by splints, should never be neglected or thought lightly of.

SPLINTS FASHIONED OUT OF PLASTIC MATERIALS.

These splints fall naturally into two divisions. In the first are placed all those which are fashioned accurately to the part, out of a mass or sheet of material which can be moulded when softened (generally by heat), and which is then allowed to set. The second division comprises those made by enveloping the part to be splinted with pieces of flannel or other suitable material of the desired shape, or with rollers, saturated with a material liquid at the time of application, but which afterwards hardens.

Division I.—In this division are included splints moulded from *Leather*, *Felt*, *Guttapercha*, or *Cardboard*, the skilful fashioning of which is an important branch of mechanical surgery.

Leather Splints.—Far too often money is thrown away with very unsatisfactory results, through the mistaken notion that the making of these splints is either below the surgeon's or dresser's dignity, or above his mechanical powers. There can be no doubt that a leather splint for such a case as a chronic enlargement of the knee, or a fractured patella, will be more efficient, if made by one who understands the surgical necessities of the case, than by an instrument maker who must, from the nature of his trade, proceed in a beaten track and according to a fixed pattern. Something of finish and

appearance will no doubt be sacrificed, but the one splint will do its work, the other, very often indeed, will not. With a little care a dresser may easily turn out a very good-looking leather splint without giving any inordinate time or trouble to it. The best leather for the purpose is ordinary *sole leather of medium thickness*, arm splints requiring a lighter kind than those for the leg. In all cases the leather should be carefully examined for flaws. The piece being chosen, it must, before softening, be cut out to the required pattern with a very sharp knife. In all cases the shape should be first *cut out in paper* and fitted as nearly as possible to the limb. The figure should then be marked out on the leather before cutting.

Splints may be made of leather for the ankle, knee, hip, spine, shoulder, elbow, wrist, and jaw. The question of spinal splints will be considered in a separate chapter ; and inasmuch as, among the rest, those for the knee and elbow are by far the most common, and as many of the directions for making them will hold good for splints fashioned out of other plastic materials, these two will be described in detail.

The *Back Splint for the Knee* is one often required for the treatment of fractured patella in the later stages of union, or for chronic disease of that joint, or after its excision has been performed. The pattern should first be cut in paper, of such a length as firmly to grasp the leg and thigh, and of a width such as will allow an interval of about half an inch between the two sides of the splint in front. The paper pattern must be carefully fitted to the part, and the leather then cut out from it. This must then be thoroughly softened in a bucket of cold water, which will take from twenty-four to forty-eight hours ; if it should be desirable to shorten this time, a tumblerful of vinegar or of dilute acetic acid may be added to the water, when three or four hours will be enough to soften the leather. The splint should then be applied to the limb, which has previously been covered with a flannel bandage, or, what is far better, to a plaster cast of the limb, and bandaged firmly, while it is at the same time moulded to fit the curves with all the exactness possible. Too much care cannot be exercised in this, the most important stage of the work. When it is done, the leather must be allowed to 'set' on the limb, a process which will take some hours, when it may be carefully taken off and allowed to dry thoroughly. It is then fit to be trimmed and finished by cutting away whatever leather is redundant, or where the edges seem as if they might chafe. The edges too must be bevelled on the inside with a very sharp knife. If it is considered advisable further to strengthen the splint with an iron backing, this may now be riveted on by a smith.

The *Lining* is best done with *Chamois Leather* ; it must be cut out from the same shape as the splint, but large enough to overlap it everywhere for about half an inch. The inside of the splint is now brushed over with very hot thin glue, and the chamois leather stuck

on. It will adhere very firmly, and the edges must be turned over and similarly fastened down, and then trimmed to an even width.

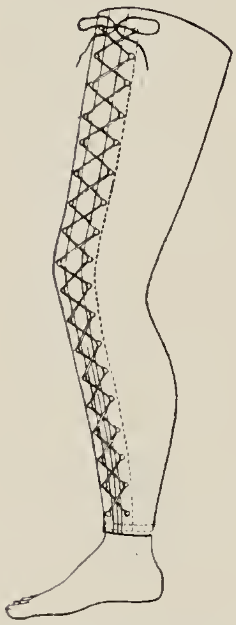


Fig. 71.—MOULDED BACK SPLINT FOR THE KNEE.

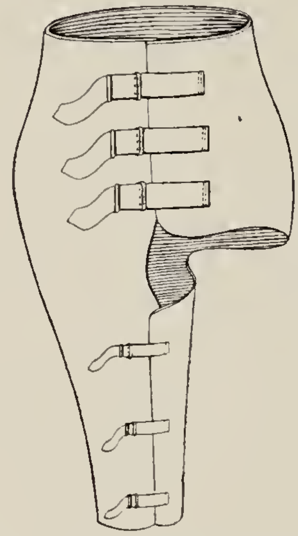


Fig. 72.—DITTO, FOR THE HIP.

The finishing toueh is given by punching the necessary holes for laeing, and inserting the brass eyelets with the proper bootmaker's tool. If it be desired to polish the leather outside, this may easily be done with beeswax and oil melted together, rubbed in while warm with a flannel.

Fig. 71 shows a knee splint finished and applied, *Fig.* 72 a hip splint.

There are two principal ways of *moulding an angular splint to the elbow*, both about equally effieient.

The pattern for the first is as in *Fig.* 73, the armpieee being cut sufficiently long to reaeh to the axillary fold, and that for the forearm to the wrist. The leather is softened as before, and then, by binding the armpieee up at right angles to that for the forearm, they will overlap each other at the elbow, the arm edges going outside. The splint thus bent is moulded by bandaging it on in the same way as for the knee, and may be trimmed, lined, and finished as has just been described. The pieces at the elbow are fastened together by a few stitches of whipcord, or by passing through, and bending over, some of the common clips used to fasten papers. This splint, it will be seen, is made of one pieee, and may be laced along the middle line in front, or fastened there by two or three webbing straps. It is shown finished in *Fig.* 74. In the other pattern, two pieces are cut out, softened, and moulded to the outer and inner sides of the arm and forearm. They may, when finished, be simply fastened round the limb by webbing or leather straps ; a neater way is to glue the two halves along the baek to a broad pieee of tape or soft leather, so as to make a hinge ; they ean then be laeed together along the front. The advantage this splint has over the

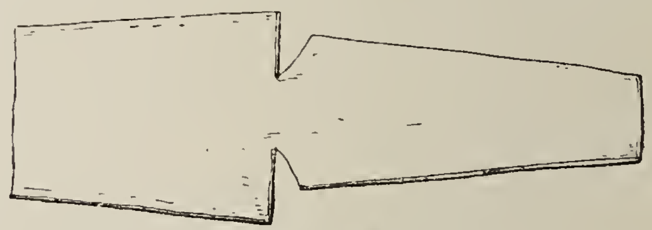


Fig. 73.—PATTERN OF MOULDED SPLINT FOR ELBOW.

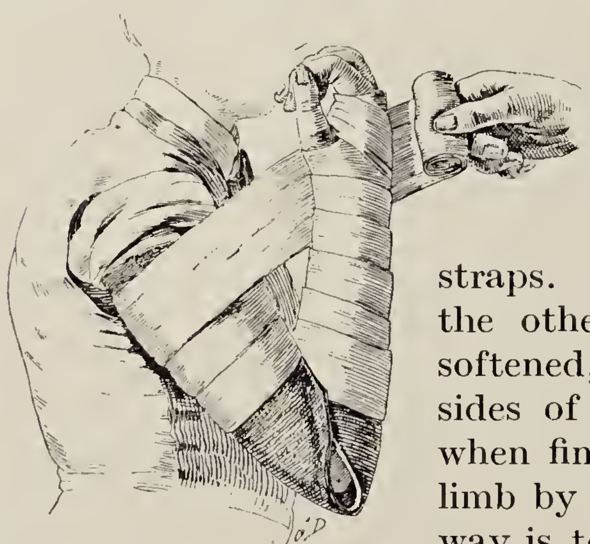


Fig. 74.—MOULDED SPLINT FOR THE ELBOW.

other is that it may be put on and off very readily; but it is more troublesome to make, and is not quite such a firm support.

It often happens that joints, suitable in other ways for leather splints, are too tender to bear the necessary manipulation of moulding. In this case it would be better to make the splint of **Poroplastic Felt,** which is easily moulded and sets quite as hard as leather.

This material closely resembles leather in its mechanical properties, but is more easily applied, and has now to a great extent superseded it for moulded splints, both large and small. It consists of felt saturated with some resin, in such a way that, while it preserves its porosity and is but slightly increased in weight, it is rendered quite plastic by heat, but becomes again extremely stiff when cold. The advantages it possesses over leather are its lightness and porosity. Its disadvantages are that it is not strong, and is more liable to crack or break. The fact that it sets very quickly cuts both ways, being sometimes useful, sometimes embarrassing. It is sold in sheets of various thicknesses and qualities ; the medium quality is the best.

As with leather, the description of the use of this felt in spinal cases is given later. With regard to other splints, most of them may be had ready made, or they may be cut out of sheets of the material. *The best way of softening* is by means of a steam chamber made for the purpose, but an oven will do very well if the felt be thoroughly moistened first. In many cases water, nearly boiling, will serve; if softened in this way, the felt must be laid flat and quickly pressed between the folds of a towel to remove the superfluous water, and then applied to the limb.

The method of moulding is in all respects the same as for leather, save that, in consequence of the extreme rapidity with which it sets, the manipulation has to be very quickly performed. These splints may be lined, and eyelet holes may be punched as in the leather, but care must be taken not to break the edges. If required, portions of the splint may be left unstiffened, or the resin may be removed from such parts after moulding by soaking in methylated spirit.

Guttapercha Sheeting comes next in usefulness to poroplastic felt, and is even more readily moulded. It is not, however, porous, and is not so comfortable as felt or leather, while in durability it is far inferior to them ; on the other hand, it admits of much more complete softening, so that it can be moulded more easily to tender parts, or to parts of a complicated shape.

The sheeting, of about the thickness of sole leather, having been cut out, is softened in water as hot as can be borne by the hands, and rapidly moulded to the part, which should first be moistened. If the water be of the proper heat, some care will be required to keep the sheet from losing its shape through undue softening, and if it be too hot this will certainly happen ; while on the other hand, water merely 'hot' (e.g., 100° F.) will not render it sufficiently pliable. The splint will set sufficiently quickly to allow it to be removed without losing

its shape, and it should then be plunged into quite cold water, which will give it greater rigidity than it would have if allowed to remain on continuously. It may then be trimmed, and, if desirable, lined and punched for lacing as before. It will, however, generally be best simply to put it on the limb over a piece of soft lint, and to secure it with webbing straps and buckles, for the guttapercha is rarely durable enough to make the former proceedings worth the trouble.

Cardboard may, in the absence of leather, felt, or guttapercha, form a fairly efficient moulded splint. After having been cut out of very stout board to the required form, the splint must be thoroughly softened in water ; and the details of manipulation are similar to those for plastic felt. In most cases, however, the best support will be obtained by cutting the millboard in strips, about 1½ inches wide, softening and then applying them to the limb, one or two at a time, while a roller is at the same time applied, so as to mould them and fix them as well. In this way the strips come to be within the layers of the bandage, and give considerable rigidity to the limb. The splint thus applied must remain on, and cannot be finished up like the preceding ones, and for this and other reasons the cardboard splints are now nearly superseded by felt.

There remain to be mentioned one or two materials occasionally used in general or special surgery, as, for example, *guttapercha* in mass, *vulcanite*, and *gum resins*. All these are principally used in dental surgery, and their employment in cases of fractured jaw will be described under that head ; but the student may be reminded that for splints of delicate construction materials such as these may be used ; so, too, metals, other than those already mentioned, may sometimes be found useful, e.g., *Lead*, *Silver*, or *Aluminium*, the last being especially valuable for its lightness, although its cost prevents its extensive employment.

Division II.—Moulded splints made of *Bandages saturated with a Plastic Material.*—Whatever be the stiffening agent used, the principle is the same for all the splints described in this division, namely, that the part required to be supported must be covered with bandages into the interstices of which there may be introduced some material which, soft at the time of application, becomes afterwards hard, so that the part is enclosed in an accurately fitting case.

The materials in common use for this purpose are *Plaster-of-Paris*, *Gum and Chalk*, *Silicate of Potash*, *Stearin*, and *Starch*. *Glue*, mixed with spirits of wine to enable it to dry, has also been used. These will be described in the order mentioned.

Plaster-of-Paris is the best and the most commonly used material for splints for injured limbs, and also for one important variety of spinal support. It is a fine white powder, obtained by burning, and thus expelling the water of crystallization from, *gypsum*, a peculiar form of sulphate of lime. Its value depends upon its power of quickly reabsorbing this water and solidifying.

In surgery it is used (*a*) As a means of *stiffening roller bandages*, as will be described below ; (*b*) As a means of giving a similar *stiffness to pieces of coarse flannel*, which, having been shaped and immersed in the plaster, are then moulded to the limb ; (*c*) For *making casts* on which splints or other material can be blocked, and for a variety of other purposes.

Whichever plan is adopted, bandage or shaped flannel, the skin must be protected from direct contact with the plaster.

Roller Bandage.—*Application.*—The part to be splinted should be first evenly covered with a soft flannel bandage, or some well-fitting clothing. The bandages, which should be about two-thirds the length of an ordinary roller, and 4, 6, 8, 10 inches wide, according to the type of cases to be treated (it should be understood that wide bandages are more effectual on the whole than narrow ones), are made of a very coarse muslin, to which the name *crinoline* is generally given.

They are prepared by rubbing the dry plaster powder well into the meshes, and then rolling up loosely. When made they should be kept dry lying on their sides in a tin box till required. They should be prepared fresh for each case, as the plaster seems to lose its power of setting satisfactorily after it has been kept for any length of time.

To make the splint it is only necessary to put the bandages in warm water till all the plaster is well soaked, and then to roll them on the limb, allowing them to take their own course to a great extent, avoiding reverses, and not attempting to form any regular pattern. The more oblique the general direction of the bandage is, and the more figures of **8** are made, the better. Many layers of the bandage are generally required to make a firm case. If it is intended to cut the plaster down so as to make it removable, as is commonly done, a ribbon of lead 1 inch wide and $\frac{1}{8}$ inch thick is laid down along the proposed line of section on the soft flannel bandage, and the plaster rollers applied over it. Before the plaster is quite dry, it is cut with a stout knife over the lead ribbon, which is thus exposed and removed, and the cut edges are trimmed and smoothed.

In all cases where a stiff bandage is applied to the leg, *great care must be taken to keep the foot at right angles.* This is easily done by passing a clove-hitch round the big toe with a long piece of bandage, which may be fastened to the head of the patient's bed, or round his neck. When the case has been applied, it must be kept quite still until it has set ; this will require from half an hour to three hours, according to the weather, the dampness of the bandages, etc. The setting may be hastened by hot-water bottles or placing the patient before a fire.

Sometimes it is desirable to *retard the setting* ; this can be done by soaking the bandages in mucilage and water. When this plan is followed, some surgeons cut the saturated and moistened bandages into strips, which are laid down, overlapping each other ; the limb

is then laid upon them and they are brought round it in order, and the ends crossed in front in a spiral fashion so as to produce the appearance of a figure of **8** bandage (*see Fig.* 29). This mode will be alluded to again under the head of 'Spinal Jackets.'

In all cases where plaster-of-Paris is used, while the bandage is being put on, a moderate amount of the plaster, moistened, should be rubbed into it, and the hands, well wetted, should be passed up and down to distribute the plaster evenly, and to rub it into the bandage thoroughly.

How to use Plaster-of-Paris.—A few words as to the manner in which plaster should be practically handled, when used for purposes of support, or any other surgical object, may be useful.

It should be recollected that, except when used on a very small scale, it is always a very messy thing to apply, and also difficult to clean up afterwards. Clothes, carpets, and everything that is upholstered should be protected or removed. Aprons and sleeves (or bare arms) will be wanted also, and rubber gloves should be worn.

If the roller bandage is the method chosen, the dry plaster, in powder, must be distributed as evenly as possible on the unrolled bandages a short time before they are wanted. But they will keep a week if they are put in a tin in a dry place.

The best way to *charge the bandages* from end to end with the powder, is to pass them over a table or board with a heap of loose plaster upon it, and then to sprinkle them with it, rubbing it lightly into their meshes : passing them on from left to right, and rolling them up at the end of the table.

The manner of *wetting the bandages* has been already mentioned. It may be added that the vessel in which they are immersed must contain water sufficient to cover them. None must be put in water until everything else is ready. Then one only is to be thoroughly wetted through and the air expelled, and as it is taken out of the basin to be applied, an assistant puts another into the water. The times of application and soaking will then coincide in a convenient fashion.

It will be seen that there is no regular rule given here for the amount of water to be taken up by the roller, and practically as much will be taken up by the powder as it lost as gypsum in the furnace, and no more.

Flannel.—A little more accuracy and practice is required if the second way of applying the plaster is adopted, namely, by so adding the dry powder to the water that the mixture is a complete and creamy fluid, in which the pieces of coarse house-flannel, already shaped as required, can be immersed and saturated, and still be flexible enough to be moulded to the limb before setting.

The best way is to take a quantity of water, in a basin or bucket, equal to about two-thirds of the quantity of plaster cream which is estimated to be wanted ; then, taking the powder and gently and slowly scattering it all over the surface of the water, let it sink by itself. This it will do very quickly at first, and then more slowly,

PLATE I

APPLICATION OF A MOULDED PLASTER SPLINT

A.

B.

PLATE II

APPLICATION OF A MOULDED PLASTER SPLINT

C.

D.

until the plaster ceases to sink, but remains on the top of a cone of thoroughly moistened plaster in the water. The contents of the basin must now for the first time be stirred, and this is best done by the hand at the bottom, and quietly, so that there are no surface bubbles ; it will soon become uniformly thick, and can be used at the consistency of rather thin cream. At the end of the setting it hardens very quickly. The cream for taking solid casts, as of the limbs or trunk, is used rather thinner than for stiffening flannel ; that is, it is used as soon as it is mixed.

Sometimes the plaster may be used as a *mass moulded between two shaped bandages.* This is, indeed, the original '**Bavarian Splint.**' These splints are usually made for cases of simple fracture of the leg, but are not confined to these injuries.

Application.—Taking the leg as an example : Two pieces of flannel or stout canvas are cut out to a pattern which can be got accurately by cutting open a stocking which would fit the patient, along the front of the leg and foot, and then spreading it out. The pieces of flannel or canvas are then laid one on top of the other (*Plate I, Fig. A*) and stitched down the middle line. The limb being laid upon them, the piece next to the leg and foot is brought round these parts and fastened along the front with safety pins (*Fig. B*). The outer piece of flannel is spread out evenly on one side, and a layer of plaster, about half an inch thick, is spread over it, care being taken to see that the plaster goes well up to the seam, both outer and inner surfaces being thoroughly covered. This side is then folded over the limb, and the same procedure followed on the other side (*Plate II, Figs. C* and *D*). When the whole is set it may be removed for inspection of the limb, the seam acting as a hinge, and herein lies the advantage of this splint : it is held in place by a bandage over it. After the splint has hardened it should be removed and left for twelve hours in front of a fire ; this will make it much firmer.

The next step is to trim it. Trimming is performed with stout scissors—all rough, uneven parts are removed from the edges, and the corners rounded off. Strips of strapping well warmed are now applied round the edges of the plaster, like braid trimming to a coat. This prevents the edges cracking and fraying, and imparts a neat, workmanlike appearance to the whole structure. It can be fixed on with strapping and bandages, can be readily removed, and lasts a long time.

This splint is much the same as that known as Croft's, which is described under 'Fractures of the Leg' (Chapter XVI).

The plaster in this and all other cases must be very dry ; it is a wise precaution to have it put into an oven for an hour before it is wanted.

The Silicate Case is made with ordinary bandages and a saturated solution of silicate of potash, with or without the addition of a little chalk or whiting ; it is applied in precisely the same way as the gum and chalk one, so that one description will do for both. In their

mechanical properties, also, the two cases are very similar. The silicate is slightly heavier, and perhaps not quite so durable ; on the other hand, it sets rather more quickly, taking from three to four hours, while the gum and chalk take from twelve to eighteen.

Gum and Chalk.—A sufficient quantity of dry powdered chalk, free from lumps, is mixed in a basin with mucilage, until it is of the consistence of gruel. The limb, being first bandaged with flannel (and in the case of the leg or thigh, the foot fixed at right angles, with the heel elevated on a block), is carefully bandaged with a common calico roller, the flannel roller extending beyond it for about half an inch. The mixture is then rubbed into the bandage with the hand so as to permeate it thoroughly. Another bandage is then put on and treated in the same way, and generally a third will be found necessary. The case is then left to dry.

The advantages of a well-made gum-and-chalk case are many. It is lighter when dry than plaster-of-Paris, and though abundantly strong, has a certain flexibility which prevents it cracking. On the other hand, it requires more time and patience in application, and the length of time it takes to set is sometimes inconvenient. It is, however, generally preferred by those accustomed to put it on.

The **Stearin Case** suggested by Lawson Tait is very clean and very rigid, but it is liable to crack. It is most suitable for limbs which require to be fixed upon splints for some length of time while the patients are confined to bed, or at least have not to move much. Thus it is a very good way of fixing the leg and thigh on to the splint in cases of resection of the knee. The paraffin is cut into small chips and heated in a vessel placed in a saucepan full of boiling water, for the wax itself should not be heated above 212° F. Gauze bandages, similar to those used in antiseptic dressings, are then immersed in the melted wax. The paraffin takes about two minutes to penetrate thoroughly to the centre of the roller. The bandages must then be applied to the limb over a flannel bandage while they are as hot as the operator's hands can bear.

Starch is the least efficient material for making a supporting case, but, on the other hand, it is one which is always ready to everyone's hand. It is applied like gum and chalk, by rubbing starch paste into the interstices of ordinary bandages. Four or even five thicknesses will be required for any useful degree of support. The limb must be kept very still while the case is drying. The chief drawback of the starch case is the shrinkage which occurs as the splint dries on the limb, which is not present when other materials are used. This may even produce gangrene, and must prove a source of anxiety, necessitating careful observation of the circulation until the splint is dry.

It may here be mentioned that a common roller bandage (e.g., one used for securing fracture splints) has a more neat appearance, and is less liable to be disturbed, if a little thin starch paste is brushed or rubbed over it after it has been put on.

Spicas.—Plaster-of-Paris or gum-and-chalk spica bandages are very frequently used in early or convalescent cases of hip disease, or in fracture about the neck of the femur. They are applied like the ordinary spica, but require a rather firmer and longer hold on the thigh. That part of the bandage which goes round the pelvis does not require to be so much stiffened as the rest.

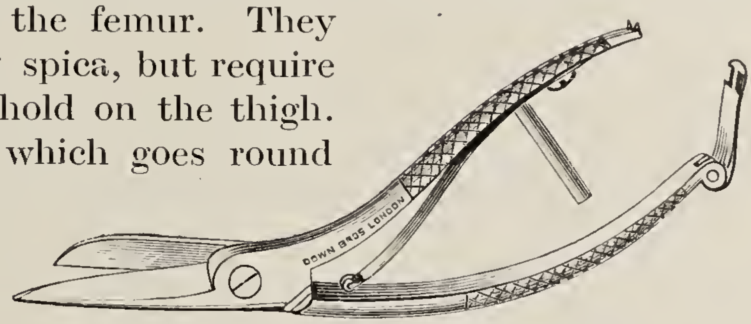


Fig. 75.—Seutin's Cutting Pliers.

It is often necessary to apply a *stiff bandage or case to some part where there is a wound.* If the discharge from this be extremely small it will be sufficient to cover it with dry lint ; but if not, an opening or 'trap-door' must be made. This is best done with a very sharp knife after the splint is firmly set, a careful note being taken at the time of application as to the exact position of the wound.

It will happen, every now and again, through chafing or some other cause, that a sore develops underneath one of these splints. In such a case no time must be lost in *cutting away the chafing part.* This may be sufficient, but very often the whole splint will have to be removed, and the sore allowed to heal. It is therefore very evident that every care must be taken while applying the case to avoid creases or constrictions in the bandages, which may lead to such serious consequences. Another common act of carelessness which may lead to the above result is that of leaving pins within the folds of the bandage.

Removal.—When plaster or gum-and-chalk cases have to be removed, a pair of strong cutting pliers (Seutin's) may be used (*Fig.* 75) ; or an instrument devised by Davy (*Fig.* 76), which is a combination of a knife and saw, and which is very suitable for the purpose, if the splint is to be cut up along the middle line without other damage so that it may be used again ; in other cases a strong jack knife will do. On the other hand, if the limb be very tender, it may be best to soak it and the splint in water until the plaster or chalk is sufficiently softened to allow of the layers of bandage being peeled off.

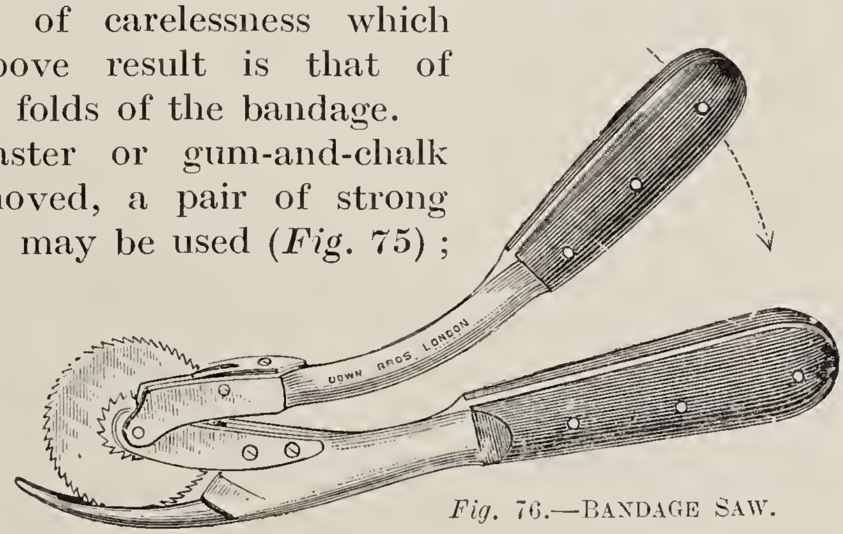


Fig. 76.—Bandage Saw.

SECTION III

OF FRACTURES, DISLOCATIONS, AND SPRAINS

CHAPTER XII

OF THE IMMEDIATE TREATMENT OF FRACTURES, IMPROVISED SPLINTING, ETC.

IN this section, only such fractures as require manipulative surgical treatment will be considered, and of these only such as the dresser or house surgeon may reasonably expect to meet with, and which he must learn to treat, during his hospital experience. With regard to apparatus and manipulations, we shall describe chiefly those which are commonly used in this country.

But before proceeding to the treatment of fractures individually, there are certain general points which must be understood.

Extent of Injury.—The first time a student makes a post-mortem examination on a recent case of fracture, however simple, even if there be to outward seeming only a very slight amount of injury, he cannot fail to be astonished at the extent to which the tissues have really suffered, at the amount of bruising and disorganization of the muscles, and at the infiltration of all the softer parts with extravasated blood. And yet, provided that such a fracture be simple, or, if compound, that septic forms of inflammation are successfully warded off, it is astonishing how quickly tissues, bruised and hurt as these are, will recover.

A further examination of a recent fracture on the post-mortem table will show that the injury of the soft parts has been to a large extent due to the working of the sharp, splintered fragments among the more yielding tissues ; indeed, in fractures by indirect violence, this is the only cause of their injury.

In considering, then, the general line of conduct in cases of fracture, the student should think of the condition of the limb inside the skin, and appreciate the fact that it is probably much worse than appears upon the surface ; and further, he should recollect that between the time of the occurrence of the fracture and its being set, careless or improper handling may do much mischief, so that it not infrequently happens that, by movements on the part of the patient or of his friends, a simple fracture is converted into a compound one ; or, though much more rarely, an important vessel or nerve is seriously injured.

It will therefore be seen that there are many points for consideration in the treatment of a case of fracture, in addition to the actual and, so to speak, permanent setting of bones.

So long as the patient can be left lying, little further harm can come to the broken bones, so that there need be no hurry.

The *chief points in the immediate treatment* of fractures are :—

1. The prevention of further injury : (*a*) By means of some improvised support or splint ; (*b*) By proper precautions in transport.

2. The arrangement of the bed on which the patient has to lie, probably for some weeks ; the getting him into it ; and the general management of affairs in the interval which must elapse before the setting.

I.—MEASURES FOR PREVENTION OF FURTHER INJURY.

I.—Improvised Splinting.—This is desirable when there is any appreciable movement between the fragments, any painful spasm of the muscles, or whenever the patient has to be moved to any distance. The ways in which more or less efficient splints may be made are very numerous, so that in this matter, the principles of the improvisation being indicated, the details must be left to the individual readiness and energy of the surgeon. Whatever comes first to hand will of course be used first, as *firewood*, *matchboarding*, *cigar boxes*, *book covers*, or *paper*, and it will hardly ever be found difficult to give sufficient support to any fracture. Even a *newspaper* will be of great service, if it be folded often enough, especially if it be bent round so as to form a portion of a hollow cylinder. *In fractures of the leg or thigh of one side*, the use which may be made of the *opposite sound one* as a splint, by tying the two limbs together, should always be remembered.

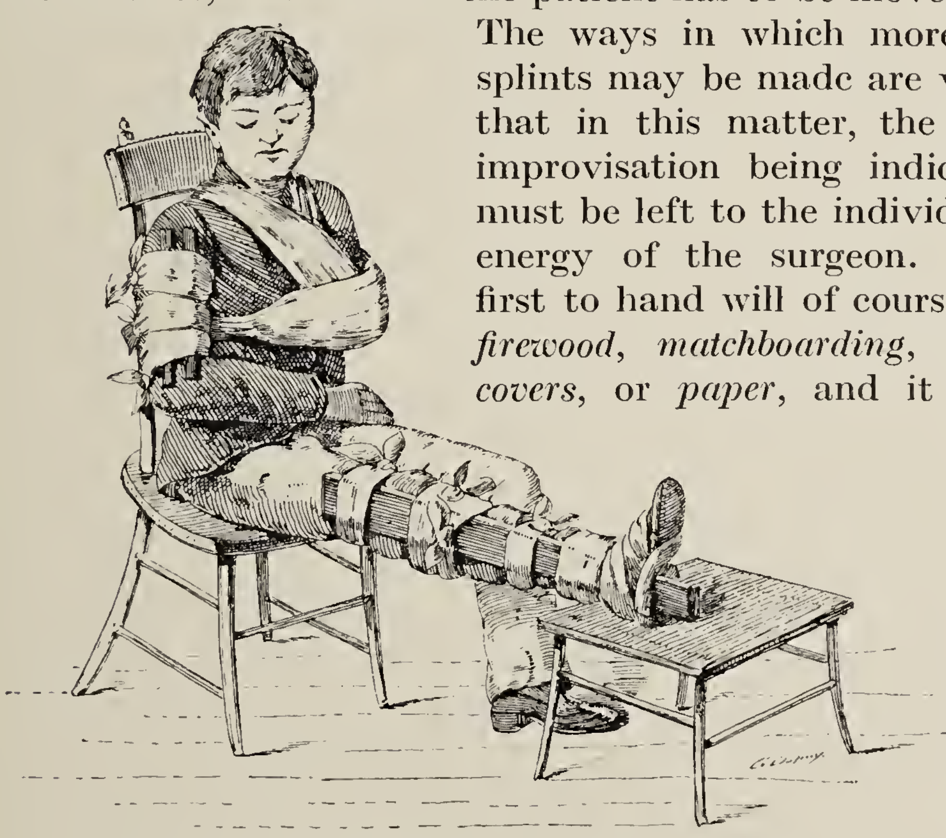


Fig. 77.—Illustration of Improvised Splinting.

Fig. 77 has been drawn to show a few of the ways in which common materials, such as firewood, towels, and handkerchiefs, may be used for the temporary support of fracture of the collar-bone, humerus, and of the bones of the leg.

As a rule *Removal of Clothes* is unwise until the patient is about to be put into bed, when it can be done deliberately, and so as to cause

as little pain as possible ; but if the fracture be badly compound, or if there be serious hæmorrhage, the clothing must be removed for more careful examination of the parts. These cases of hæmorrhage in connection with fracture are always serious, and the necessity of attending to this condition will take precedence of the question of supporting broken bones.

Improvised splints should always be put on in a way which will allow of their ready removal, and in applying them no effort need be made to replace the fractured parts accurately, but merely in a general and gentle fashion to reduce the deformity and give support.

The following directions will serve as examples of what may be done in some of the more common accidents involving fracture of bones, in the way of a rough and ready splinting, it being understood that they are *examples* only.

1. **Fractured Lower Jaw.**—This is a result of some direct violence, and there will be a good deal of bruising of the soft parts. All that will be required in the first instance will be to tie up the lower jaw against the upper one with a soft handkerchief, passed under the chin and over the vertex of the skull. The patient must not talk, and if any nourishment has to be taken it should be poured slowly into the mouth at one of the angles.

2. **Broken Collar Bone.**—This may happen in adults from direct violence, as by a bullet or any severe direct blow ; in such a case the symptoms will be well marked. Or it may occur at birth or in young infants, by rough handling or slight drags or falls, in which case it may often be overlooked. But it is generally the result of an indirect shock, as by falling on the shoulder, or on the outstretched hand. The patient instinctively supports the elbow and forearm of the injured side with the other arm, and so pushes up the shoulder, which would otherwise droop. If the patient can be conveniently put to bed on a hard mattress *flat on the back*, with a small pillow between the shoulders, and a very small one (or none at all) under the head, the fragments of the clavicle will come absolutely into apposition. But often when this accident happens the sufferer has to travel for some distance ; and although by merely slinging the arm all risk of any great additional damage will be avoided, a better plan is to use a couple of towels or triangular bandages in the way now to be described. With these the arm can easily be fixed in a position which will give complete comfort, and indeed, in many cases will bring the fragments into sufficiently good position to enable union to take place without any noticeable deformity. This method is also suitable for the permanent setting, and is mentioned later on under that head.

The Indications to be fulfilled in cases of fractured clavicle are—that the shoulder must be pushed well up, the arm must be fastened to the side with the elbow behind a vertical line dropped from the point of the shoulder, and that the shoulder-joint should be forced away from the thorax by a pad placed in the axilla, to counteract the tendency

of the broken ends of the elavicle to overlap. A way in whieh this may readily be done is shown in *Fig.* 78 (and also in *Fig.* 77). A soft but firm pad, of about the size of the fist, is made, as with a cricketing cap or a newspaper, and plaeed in the axilla ; the forearm is erossed over the chest, with the hand pointing to the opposite shoulder, the point of the elbow being held well baek. A towel is folded as a broad searf, the elbow is settled into the middle of it, and then, by tying the ends over the opposite shoulder, the hand and forearm being covered by the scarf, the arm on the injured side is pushed well up. The other towel is now brought round so as to fasten the arm, forearm, and hand firmly to the trunk, and the ends are knotted or pinned beneath the opposite armpit. A referenee to the figure will explain, better than words ean do, these simple but efficient arrangements.

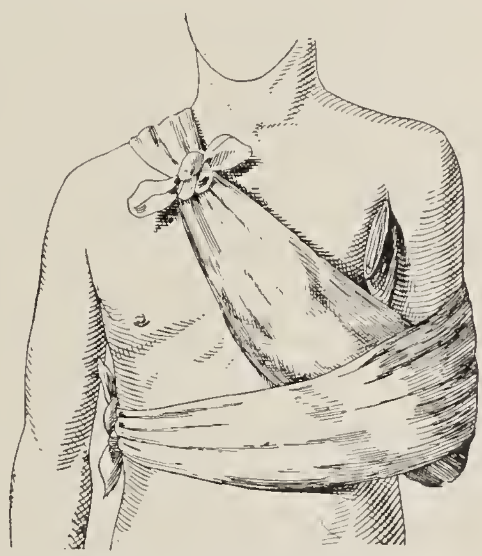


Fig. 78.—Treatment of Fractured Clavicle with two Towels or Triangular Bandages.

3. **Fracture in the Neighbourhood of the Shoulder-joint.**—For this, inasmueh as both the displacement and mobility of the fragments are often either slight or obscure, a well-adjusted sling is all that is required at first, or during the removal of the patient.

4. **Fracture of the Shaft of the Humerus.**—Here the displacement may be considerable, and the ends of the broken bone, by moving on each other, may eause mueh pain and muscular spasm. The weight of the forearm must be utilized to prevent overlapping of the fragments, and a little gentle traetion may be made at the elbow. Some short pieees of firewood or eardboard should then be tied round the limb, outside the sleeve, with handkerehiefs, or something of the kind, eare being taken that those on the inside are so short that the eireulation is not impeded at the elbow (*see Fig.* 77). The hand and wrist should then be slung in a towel folded searf-wise.

5. **Fractures about the Elbow-joint.**—The forearm should be slung, but it will be unwise to attempt any reduction of the fracture, whieh is often complicated with dislocation, till arrangements have been made for its regular setting.

6. **Fractures of the Bones of the Forearm.**—The limb should be supported by two splints, whieh need not be very rigid (brown paper folded several times will do very well), plaeed along the front and baek of the hand and forearm, and reaehing from the elbow to beyond the tips of the fingers. The hand should be plaeed midway between pronation and supination, with the thumb upward ; the splint on the flexor side must not embarrass the braehial artery when the arm is bent. The splints may be tied on with handkerchiefs, and the arm supported with a broad sling.

7. **Colles's Fracture of the Wrist.**—A simple sling is all that will generally be necessary, but sometimes, when there is painful spasm of the flexors of the fingers, relief is afforded by a soft splint along the front of the hand and forearm, lightly tied on. The fracture should always be set as soon as possible, in one of the ways to be described later.

8. **Fractured Ribs.**—When an accident has happened which in the nature of things may have caused one or more ribs to give way, and the patient complains of a stabbing pain or 'catch' in the breath on inspiration, with other signs of embarrassment of the breathing movements, it will not be necessary in the first instance to distinguish whether there has been a bruising or an actual fracture of the thoracic walls. In the majority of cases it will be found that immediate relief is afforded by placing the hands on either side of the chest, and compressing the thoracic walls gently but firmly. Very often the patient will have found this out, and may even have tied his scarf tightly round his body. Until a more complete support can be given to the thorax by strapping and bandaging, something in the way of a scarf or towel must be tied round the chest with the tightness which will give the greatest amount of relief.

A patient with broken ribs may thus be able to get home without much suffering, but he should be cautioned against any movement which would require any but the shallowest respiration ; for though he may be comfortable enough so long as the diaphragm alone is concerned in the performance of breathing, his pain would be much aggravated by any effort which would bring the chest walls into play.

9. **Fractured Spine.**—Whenever, or under whatever circumstances, the back appears to be broken, no question of splinting can arise ; but the harm, or rather the disaster, which may be wrought by rough or careless handling cannot be too thoroughly realized.

The symptoms of fractured spine being present, the injured person should be placed in the supine or prone position, on the ground, with the trunk as straight as possible under the circumstances. In the absence of a stretcher, a gate, hurdle, shutter, or some other rigid platform should be procured, and placed close to the patient, who must be placed on it with the least possible alteration of position. (For the methods of transportation, see p. 114.)

10. **Fractured Pelvis.**—This may occur from a fall, but in most cases the cause will be the passage over the pelvis of some crushing weight, as the wheels of a wagon. Little requires to be done in the first instance ; but relief may be given by tying a broad scarf or belt round the pelvis. The patient must be quickly placed on a stretcher or its substitute. It sometimes happens, even after a severe injury to the pelvis, that the patient is able to walk after a fashion, but this must never be allowed.

11. **Fracture of the Neck of the Thigh-bone.**—(*a*) *Fracture in old people.* This will only require that the patient be moved with

gentleness on a stretcher ; no additional precautions are necessary. (*b*) *Fracture with violence*, and injury to the softer parts around. This is usually extracapsular, and generally occurs in adults. In any case precautions must be taken to prevent further damage in removal ; these, however, will be practically the same as are required in the following case.

12. **Fracture of the Shaft of the Femur.**—In consequence of the length and strength of this bone, its fracture may be attended with great disorganization of the surrounding parts, and the injury is very easily made more serious still by rough or unskilful handling. In these cases the principal difficulty is that of transport, and the reader has only to imagine what might be the consequence of ill-advised efforts to move a heavy man with his thigh broken in the middle and unsupported, to see at once that no attempt should be made to move an adult thus injured till the limb has been rendered fairly stiff by improvised splinting. The end desired is practically to make the patient's body rigid from the armpit to the ankle, so as to prevent all risk of bending or buckling up of the broken ends of the bone, which would otherwise readily occur. The patient should be kept lying *absolutely flat on the back*, and search should be made for something long and strong enough to serve as a '*girder' to run the whole length of the body* (a rifle or a broomstick will do admirably). This must then be laid along the injured side, the top going beneath the axilla, and the limb should be very gently straightened, since by this time it will probably have become much abducted and rotated outwards. Then, with numerous handkerchiefs, towels, etc., this long splint must be fastened on, passing the bandages round thorax and pelvis. Along the inner side of the leg *a short splint*, say an umbrella, should then be placed, and a back splint of thin board, or stiff paper folded, may be added along the back of the thigh. These supports must then be fastened round the thigh, leg, and foot, as can best be managed. Finally, *the injured limb must be tied to the sound one in two or three places.*

If these proceedings have been thoroughly carried out, it should be possible, though it would be unwise, to carry the patient simply by the head and heels, without any bending.

13. **Fracture near the Knee-joint.**—Here the risk of injury is very much less, and one of two plans may be adopted. If the limb be lying fairly straight, an inside and an outside splint, as two walking-sticks, should be tied on with several handkerchiefs, avoiding the actual seat of fracture ; or what will be found more comfortable, especially if the limb be bent, place beneath the joint a thick pillow or other support, keeping it in the flexed position with a few bandages tied round all.

14. **In a Fractured Patella,** the great indication is to avoid increased separation of the fragments and further damage to the knee-joint beneath. This is best done by a strong back splint of

umbrellas or boarding, running behind the whole length of the thigh and leg, and tied on firmly with handkerchiefs.

15. **Fractures of one or both Bones of the Leg** generally occur from direct violence ; and because the skin is so thin over the shin bone they are very apt to become *secondarily compound*, and may be so from the beginning. These fractures are thus often extremely severe injuries, and require much care and gentleness in handling. If the limb be very much crushed, with comminution of the bones, whether the fracture be compound or not, probably the best plan will be to take a soft pillow and arrange the stuffing so as to form a trough, lay the limb in it, and tie it up with soft bandages. In slighter cases, splints long enough to reach below the feet must be put on both the outer and inner sides, or on the outer one only (*Fig.* 77). If the boot can be easily taken off, as by cutting up the side springs or laces, this should be done, but it should be left alone if it seems that removal could cause the slightest damage.

16. **In Pott's Fracture with Dislocation of the Ankle-joint,** it is unwise to use any force to rectify the deformity, which is often considerable. The boot should be cut off, and a splint, extending from the knee to below the foot, should be put on the inner or the outer side, as seems best, with handkerchiefs. The foot should be placed in as nearly a natural position as it will readily come to.

Finally, in those cases of **Compound Dislocation of the Ankle,** or of a *general crush* of the parts about the foot, caused by great violence, little can be done, except to tie the parts up in a pillow, or to use such other materials for soft support as the circumstances of the case will admit.

II.—Method of Transport of Cases of Fracture, and Precautions to be taken therein.—In military surgery it naturally happens that great stress is laid upon the best ways of moving people helpless from injury, whether through fracture or otherwise. A regular stretcher drill is laid down, and other plans for lifting and carrying are carefully considered ; but in civil practice, and in connection with the proper work of house surgeons and dressers, elaborate descriptions of the different kinds of stretchers, and of kindred details, would be out of place ; still, it is desirable that all civilian dressers, surgeons, or porters, who have to do with helpless people, should have some acquaintance with the best ways of lifting and moving them, and one or two of these ways will here be mentioned, supposing always that the injured person is unable to walk at all. (The case of children need not here occupy our time.)

If two people only, A and B, are available for the transport, and the person is able to sit up a little, the best way to manage will be for them to make a 'sedan chair' by crossing their arms. Of this 'chair' there are three patterns, but one only is figured, because it is the best for general use.

In the *First* of the other two plans, the fingers of the right hand of A and the left hand of B are interlocked to form a seat, while A's left hand is placed on B's shoulder, and *vice versa*, to make a back support.

In the *Second* plan, both of A's and one of B's hands are joined to form a triangular seat, and B's other hand rests on A's shoulder, forming a chair back.

But the *Third* way (*Fig.* 79) is the best, where both pairs of hands are used, locked together to form a seat, and the patient supports himself by his hands placed upon the bearers' shoulders.

If the Patient be quite Helpless or Senseless, whether he has to be carried any distance, or has only to be lifted on to a stretcher or bed, the assistance of three people is desirable, two, A and B, to do the lifting, and the third, C, to look after the injured limb and the patient generally.

A and B take up a position on the opposite sides of the patient, near his haunch bones, facing each other ; they then stoop down, and each gradually gets one hand under his back, near the shoulder-blades, till they meet and are clasped ; the other hands are then passed and locked under the breech. Having secured a firm grasp they rise together from the stooping posture with the patient, and are ready to move. It is not advisable for either to kneel, unless they cannot stoop low enough ; but if one does, both must.

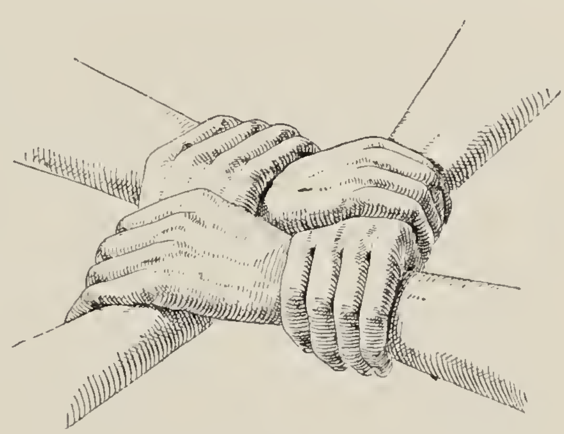


Fig. 79.—Hands forming Sedan Chair.

A patient lifted in this way can readily be placed on a bed, or be lowered on to a stretcher for more convenient carriage. In lifting a stretcher, the taller of the bearers should go to the head, and should give the directions as to the time of lifting. The head ought always to be lifted a little before, and lowered a little after, the feet. *In carrying anyone* on a stretcher, the bearers should *not keep step*, but the left foot of the one must be put forward with the right of the other, to avoid swaying. It is not here considered necessary to give an account of the actual stretcher drill, where the bearers are numbered off, and have their several duties sharply defined, for the purposes of military discipline.

With regard to conveyance from the scene of the accident, the ambulance service in the cities and country towns is so well organized that delay rarely occurs ; but if the accident occurs in the country, it is better to obtain the services of a lorry rather than of a private car, so that the patient may be lying down during transit.

Lifting Patient to Bed.—When a patient has been brought to the bedside, the bed being ready, he should, if completely disabled, be very gently lifted on to it, and the knowledge of how to do this

properly and with the least discomfort to the patient does not come naturally.

The stretcher, or whatever the patient has been carried on to his bedroom, is placed on one side of the bed, say the left side ; those about to lift him kneel on one knee on the patient's left, and after carefully inserting their hands and forearms well under him, at a given signal rise to their feet and lift him gently. An assistant then draws away the stretcher, and the lifters, taking a pace forward, gently deposit the patient in the centre of the bed. With a sufficient number of assistants this manœuvre may be done expeditiously and without pain.

It may also be done by placing the stretcher with the patient's head at the foot of the bed. The assistants, kneeling on either side, insert their arms well under the patient, and at a given signal rise to their feet and lift the patient up. By moving along sideways the patient is brought over the bed and gently deposited.

This method is not so good as the former, but it allows of more assistants being employed, which is convenient in the case of heavy people. The lifters may either lock their hands under the patient, or, still better, grasp each other's wrists.

The patient having been placed on the bed, the clothing should be removed, cutting off the boots and ripping up the seams of the clothes, if this has not been done before, the sound arm or leg being the one which should first be slipped out of the sleeve or trouser. As a rule, everything in the shape of temporary splints may now be taken off, and the limb should be placed in the most natural position in which it will easily lie, on a pillow fashioned into a kind of trough. *Sand-bags* are very often useful in restraining spasmodic movements or in steadying the limb. All pressure of the bedclothes must be taken off by a regular *cradle*, or one improvised out of some such thing as a bandbox split open. If the case be a severe one, especially if there be much spasm, a hypodermic injection of morphia will now be found very useful.

2.—OF FRACTURE BEDS.

There are certain points to be looked to with regard to the bed on which a patient with a fractured limb will have to lie, and inasmuch as it is probable that once there, any further movement will be hurtful, they should be considered and met *before* the patient is placed on it.

The Essential Qualities which the bed should possess are, that there should nowhere be any 'sagging' or possibility of giving way, that the surface should be evenly smooth and comfortably elastic, and that the foot of the mattress should be somewhat higher than the head.

In practice it will be found that very few bedsteads fulfil these requirements ; even the best (the wire-woven beds, or those with interlaced iron bands) will allow of a certain giving way where the greatest weight of the body lies, while this occurs to a much greater

extent in sacking or sofa spring beds. The evils of this yielding and the formation of a hollow under the patient are not so apparent at first as they become afterwards ; the patient gradually slips down, the head and shoulders are pushed forward, and the heels come up, until, instead of lying in a straight line, the body forms two sides of a triangle, the apex of which is at the ischial tuberosities, to the grievous alteration of the parts about the seat of fracture, and to the great risk of the formation of bedsores.

Fortunately the remedy is easy, and involves no apparatus, all that is required being a light wooden frame or a few light boards placed on the bedstead, underneath the mattress. If the mattresses are of the kind to be described directly, no discomfort will be felt after a very little time from the rigidity of these boards, even by those who are accustomed to lie softly, while they are quite as efficient as any special bedsteads that have ever been devised.

A big bed is a misfortune in all cases of sickness, but especially in fractures. The *best size* is that of the ordinary single bed, as found in hospitals and elsewhere, namely, 6ft. 6in. by 3ft. or 3ft. 6in.

It is of great importance that the *Mattresses* in fracture cases should possess the qualities of smoothness and elasticity in perfection, and for this reason any form of 'bed,' either of feathers or other material, is quite inadmissible. Flock mattresses are objectionable, as, even if well made, they tend in time to form knots or lumps. The best combination of all is a straw palliasse and, over that, one or two horse-hair mattresses, 3½ in. to 4 in. thick. Over the mattress one blanket is generally found of service. The sheets require no particular directions, save that, if a draw-sheet and macintosh are required, they should be arranged before the patient is put to bed.

In cases of fracture of the lower extremities, or of the spine, *all* pillows or bolsters are harmful, except the merest cushion beneath the head, at any rate in the early stages of union ; and if the patient can be induced to lie thus flat, the position will not cause discomfort after the first day or two. Any pillows should be small and firm, and covered with separate slips.

CHAPTER XIII

OF MASSAGE, MANIPULATION, AND PASSIVE MOVEMENTS IN FRACTURES

(*See Graham on Massage*)

ALTHOUGH the value of massage was recognized by ancient writers on surgery, and although it was widely applied with satisfactory results by the Greek and Roman physicians, its introduction into our surgical treatment is comparatively recent. The introduction of a mode of treatment of unquestionable benefit in the treatment of sprains and fractures has led to a swinging of the pendulum of surgical opinion in a direction very opposite to that of some twenty-five to thirty years ago.

At that period the routine treatment of fractures, sprains, and dislocations was rigid confinement by some retentive apparatus until such time had elapsed as was considered necessary for the repair of bone or for the removal of the exudation. This period extended over several weeks, with the result that when the splints were removed the joints were stiff, the muscles wasted, and it was long before the affected limb recovered.

No sooner was the beneficial effect of massage generally recognized, than some pioneers of this method of treatment advocated its adoption in the case of fractures and other injuries to the entire exclusion of splints and other apparatus designed to keep the parts at rest.

It is not our business to enter at length into this question, but we would state clearly that both massage and passive movement can be overdone : this without for one moment disparaging the treatment under proper conditions.

We are further of the opinion that fractures and severe sprains are best treated at the start by those principles which govern us in the treatment of any extensive injury, namely, rest and fixation ; it seems to us inconsistent not to keep parts quiet which have been subjected to considerable bruising and laceration. Further, while we admit that the treatment of fractures without retentive apparatus has given some excellent results, we cannot advise it as a routine, especially for hospital cases, where daily inspection may be difficult. The same may be said with regard to passive movement. Doubtless the cautious and well-regulated practice of passive movement in cases of fracture is to be highly commended, but the greatest care is required in its application. Unless a surgeon realizes this, he may often do more harm than good in attempts at passive movement. Certain recommendations as to the methods of performing these movements will be

given below, but we may remind our readers that passive movement may easily displace the two surfaces of a broken bone which have been brought into apposition with some difficulty, and further, by irritating the damaged bones may cause the formation of exuberant callus.

It may be well to point out the manner in which massage and passive movements act. Massage is of special value in getting rid of the effusions which have been poured out as the result of injury. These effusions are pressed into the lymph-stream and readily carried off by the manipulations described.

Both massage and passive movement are of value in preventing the formation of intra- and extra-articular adhesions. In many text-books the student gathers that adhesions are formed in the joints alone, but this is by no means the case. When a fracture (or sprain) has occurred in the neighbourhood of the ankle, the joint may or may not be damaged, but the tendons which lie in relation to the lower end of the tibia are involved in a plaster of extravasated blood and lymph. If they are allowed to remain in this state, organization will occur, and they will become matted together and almost immovable. The application of massage, and of passive and (at a later period) active movements, is the very best means at our disposal for the prevention of this complication. Should such adhesions form in spite of treatment, they must be broken down under an anæsthetic.

Finally, both massage and movements improve the tone of the muscles and of the vessels of the limb. When a limb, especially the lower extremity, has been fixed immovably on splints for any length of time, an attempt to use the part after removal of the apparatus is usually followed by painful swelling and œdema. The same occurs in some patients after simple confinement to bed for a long period. This swelling is due to loss of tone of the vessels, so that, as soon as any extra strain is thrown upon them, transudation takes place into the tissues.

The muscles are thrown out of action by long fixation on a splint ; they waste, and as a result, when the fracture has healed and the patient is ready to get about, the atrophied muscles are incapable of doing their work, and convalescence is thus delayed until they recover. The importance of muscular wasting in association with sprains and damage to joints is best illustrated in the case of the knee-joint. When this region has been damaged and the part immobilized on a splint for any length of time without massage, the quadriceps muscle wastes considerably. As soon as the patient begins to walk about he finds his joint weak and liable to give way. He therefore applies an elastic supporting bandage, which further induces muscular atrophy. Now one of the functions of the quadriceps is to keep the synovial membrane of the knee under control during the movements of the joint. When the muscle has atrophied, the joint capsule and synovial membrane are lax, and folds of the latter membrane get

between the articular surfaces (especially the folds on either side of the alar ligament) and are nipped. The result of this is an attack of synovitis, for which a splint is again applied, and so the patient goes on, until the joint passes into a state of chronic synovitis with serous effusion, or a condition of permanent weakness (called by Bennett 'wobbly joint'). All this may be prevented by the early use of massage and passive movement. The muscles are exercised, and a free circulation through their capillaries is induced.

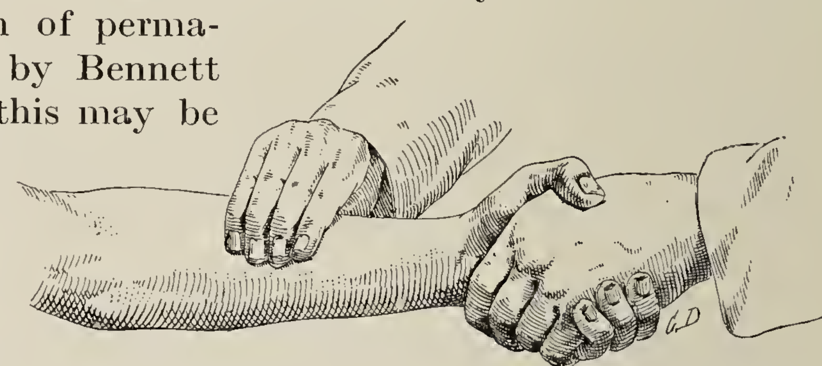


Fig. 80.—Effleurage Carried out with the Finger-tips.

Massage, from the Greek μασσω, I knead or handle, has many forms. For our purpose we shall only consider two : *effleurage* or *stroking*, friction of the limb towards the trunk or in the direction of the lymph flow; and *pétrissage* or *kneading*, deep massing or palpation of the muscles by gentle squeezing of the part by the palm of the hand and fingers. The other varieties are more elaborate, and do not concern us here.

Effleurage.—In practising this operation some neutral powder or even some greasy preparation (this is not very pleasant) is applied to the patient's limb, and if the limb is very hairy it may be shaved. The operator, usually seated, gently strokes the surface of the affected limb with the palmar surface of the hand with a rhythmical movement, in a direction toward the trunk (*Figs.* 80, 81)*; he should employ as large a surface of his hand as possible, and the hand should never press heavily. The fingers are treated by taking them between the finger and thumb and stroking gently towards the palm.

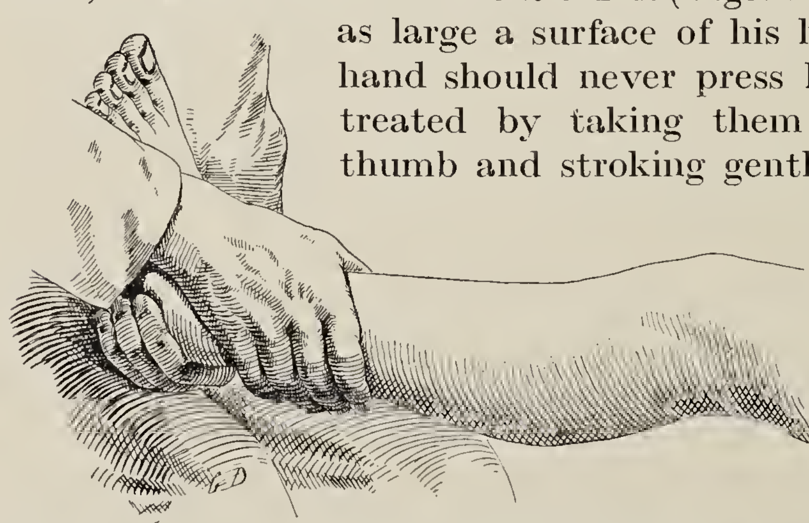


Fig. 81.—Effleurage performed with the entire Palm of the Hand rapidly moved towards the Knee.

Pétrissage is performed somewhat differently. As large a grasp of the limb as possible is taken with both hands, and the thenar portion of the palm is pressed into the tissues, by alternate movements of the two hands (as the right contracts and compresses the muscles the left relaxes). The long axis of the operator's hand should lie parallel with the long axis of the patient's limb, and the thumbs should be directed

* *Figs.* 80–83 are from *Natural Therapy*, by the late T. D. Luke, M.D. (Bristol: John Wright & Sons Ltd.), by kind permission.

towards the patient's trunk. Working in this manner, and starting at the distal extremity of the limb, the operator approaches gradually the proximal end (as for example the shoulder in the case of the upper extremity), and then starts again at the fingers or distal end (*Figs.* 82, 83).

This very brief description of the varieties of massage and their application is only intended to assist house surgeons in treating their own cases, since a general description of massage is beyond the scope of this work. The best plan is to watch a masseur at work; but if the above instructions are followed out, the dresser or house surgeon will often be able to help his fractures and get some practice in the application of massage which will be very useful to him.

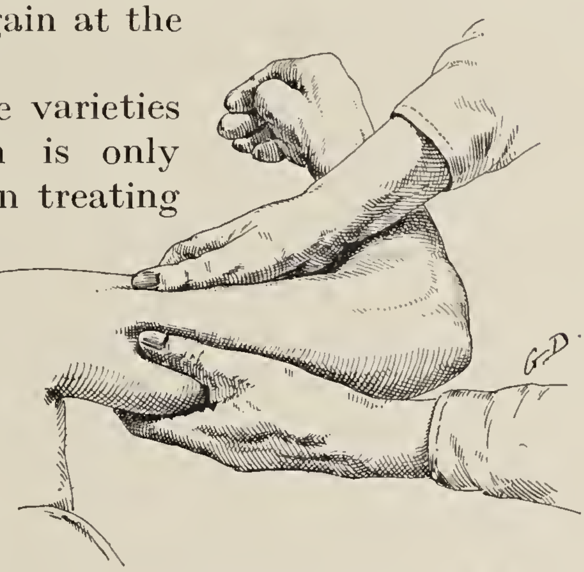


Fig. 82.—PÉTRISSAGE OF THE ARM MUSCLES WITH VIBRATORY MOVEMENT.

It is important to appreciate where massage should be started in cases of fracture and sprain. If the operator start at or just below the seat of injury, considerable pain will be caused. In all cases it is advisable to start *above* the injury—that is, nearer the trunk. Taking as an example a bad sprain of the ankle, begin in the middle of the leg and work up to the thigh, starting each successive time nearer the point of injury, until it is finally reached. The object is, first, to assist the vessels in carrying off the exudation, and, secondly, to accustom gradually the bruised tissues to the movements.

As soon as the massage has been completed immediately above the injured area, the operator should turn his attention to the distal extremity, and beginning with the digits work cautiously upwards towards the damaged part. He will now find that gentle friction over this area will be tolerated by the patient, and finally, at the end of the sitting, he will most probably be able freely to massage the bruised tissues.

Fig. 83.—PÉTRISSAGE WITH A SINGLE FINGER OR THUMB, TO REMOVE INFLAMMATORY EXUDATES.

Passive Movement.—This is a movement of a joint in the neighbourhood of a fracture or sprain, undertaken by the operator, the patient being passive, i.e., keeping his muscles as far as possible relaxed, and taking no part in performing the movement. Not only does this movement tend to improve the nutrition of the muscles, but it also prevents the formation of adhesions.

In performing passive movements in the early stages of treatment,

the greatest care must be taken not to displace the fragments, whieh must be held steady in some way. In eases of fracture about the elbow, a hinged splint may be fitted, whieh will permit flexion and extension without the limb being removed from the apparatus.

In all eases the fraetured bone must be held by one hand of the operator, while the other gently begins the movements required, usually flexion and extension.

In the ease of Colles's fraeture, the fingers ean be freely moved without removing the palmar splint; when it beeomes neeessary to move the wrist, the fraeture must be held by one hand, the thumb being placed on the baek of the lower fragment and the fingers on the front of the upper fragment.

In performing passive movement it is necessary to have an accurate knowledge of the situation of the fracture, and of the direction in which displacement is likely to occur.

The range of movement must be very limited at first, but be gradually inereased. If earefully applied, passive movement should be practically painless, and the inflietion of pain should be looked upon as an indieation that the movements are too vigorous.

Injuries produced by too energetic Passive Movement.—

Displacement of Fragments.—This has already been alluded to.

Traumatic Synovitis.—If a joint has been severely damaged, and passive movement overdone, it is not uneommonly found that the joint beeomes swollen and aeutely tender after the manipulations.

Non-union.—It is an open question whether movement leads to non-union: some authorities maintain that movement of the fragments on one another is benefieial, and that union takes plaee more readily under these conditions.

Excessive Formation of Callus.—This is eertainly eaused by too vigorous passive movement in the early stages of fractures.

Active Movements and Movements against Resistance. — These movements are not to be allowed until there is fairly firm union between the broken ends. Sueh union is present about the third week in most fraetures.

In movements against resistanee, as opposed to passive movements, the operator endeavours to flex and extend the limb against the eontraction of the museles voluntarily exercised by the patient. In the later stages of treatment these movements are espeeially valuable in keeping museles and tendons exereised.

Free aetive movements may be permitted some weeks before retentive apparatus is disearded, and in eases of Pott's and Colles's fraetures the patient should be eneouraged to move the foot and ankle or fingers and wrist some time before attempting anything in the nature of walking or earrying.

The duration of eaeh applieation of massage should be from fifteen to thirty minutes, and the treatment should be continued every day, or every other day, until function is restored.

CHAPTER XIV

OF THE PERMANENT SETTING OF FRACTURES

FRACTURES are at once the most frequent and the most important of the accidents with which a house surgeon may have to deal. Apart from the great difficulty in arriving at an exact diagnosis in certain cases, so many problems present themselves during the treatment, and so many complications may ensue, that the student will do well to study examples of these injuries with the greatest care during his time as a dresser.

Bad results, which are unfortunately too common, can only be avoided by the exercise of constant attention during the after-treatment. A bad result is often considered a reproach to the surgeon attending the case, and in some cases he must be regarded as responsible for it. At the same time, if he has conscientiously followed out an appropriate treatment with every care, although in many instances his results may not be perfect, he cannot be regarded as in any way to blame. Fractures among the working-classes are very serious injuries. The patient is of necessity kept from work for a long period, and if the bones have united in a bad position, or if a joint has become permanently stiff, the wage-earning capacity of the sufferer may diminish to vanishing point.

It is necessary to say a few words about the diagnosis of fractures before considering the main principles which should govern our treatment. In many cases the classical signs of fracture are so obvious that an unpractised observer will have no difficulty in at once deciding on the nature of the injury. We briefly state the main points.

Signs of Fracture.—

1. *Signs of local injury*, such as bruising of the limb or superficial wounds.

2. *Deformity.*—Alteration in the natural outline of the part as compared with the opposite side. *When possible, in the case of any injury of the extremities, shoulder, or hip, a careful comparison with the sound side should be made.*

3. *Local tenderness* over the seat of the fracture.

4. *Shortening*, the fragments in complete fractures tending to ride over one another owing to the contraction of the muscles.

Measurements should always be made between two prominent bony points, and compared with similar measurements made on the opposite side—as, for example, a measurement from the acromion process of the scapula to the external condyle or the olecranon, in cases of injury to the humerus.

A word of warning may be given on the subject of these measurements. It is by no means uncommon to observe a great discrepancy between the measurements obtained by two separate observers, this being due to : (*a*) Inaccuracy in applying the measuring tape to the bony prominences ; and (*b*) Failure to put the sound limb in a position as nearly similar as possible to that of the injured one (*Fig.* 84).

The subcutaneous bony points of the body used for measurement are not by any means exact. In the case of the anterior superior spine of the ilium, an area of at least an inch can be called subcutaneous, and it is easy to see how a measurement carelessly made may fail to reveal a shortening of half to one inch. A good rule to follow is this—*Before measuring, mark with a skin pencil or with ink, as accurately as possible, the exact points on the two sides between which the measurements are to be taken.*

With regard to (*b*), we will instance injuries round the hip-joint. If in these cases the measurements are made with one limb in adduction and the other in abduction, errors are bound to

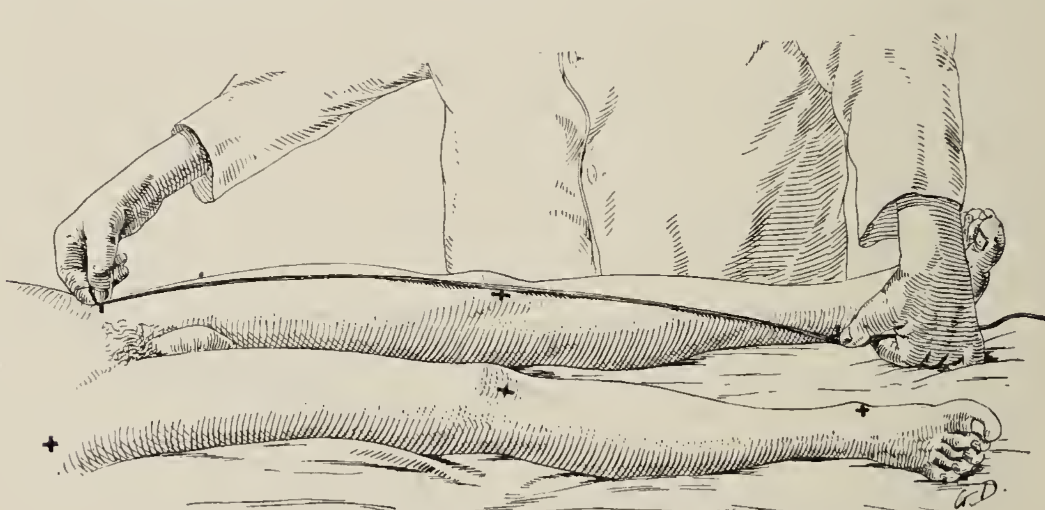


Fig. 84.—Measurement for Injury about the Hip.

arise. In adduction there is a greater distance between the anterior superior iliac spine and the internal malleolus than in abduction.

5. *Alteration in the position of certain bony processes to one another.*—This is best illustrated in Colles's fracture of the radius, where the position of the styloid processes of the two bones to one another is changed.

6. *Abnormal mobility* of the limb or part owing to the loss of continuity of the shaft of the bone. In some cases where the fracture is comminuted or splintered the lower part hangs loosely and uselessly from the rest of the limb.

7. *Crepitus.*—A peculiar grating caused by the rubbing of the fractured surfaces on one another, communicated to the hand of the surgeon when he is examining the case. Although a sign of the greatest value in indicating clearly the presence of a fracture, the utmost care must be taken in eliciting it, since the endeavour to do so may not only cause intense pain, but may damage the soft parts.

But while any or all of these valuable signs may be present in a given case, there are many examples where most of them are absent, and the case then may present the greatest difficulty. In fractures near joints, swelling may mask all the bony prominences. Deformity may be absent owing to the fracture being incomplete, or for other reasons. Crepitus may not be obtained owing to impaction of the fragments. Pain, however, is rarely absent.

In such cases as these, it is clear that the diagnosis cannot easily be made, and we would suggest the following rules.

1. In cases of injury where it is possible that a fracture has been sustained, treatment appropriate to a fracture should be undertaken ; and the case considered to be one of fracture until further investigation has proved the contrary.

2. Never in a doubtful case say "There is no fracture," but rather, "I find no evidence of fracture at present."

3. When possible, submit every case of *recognized* or *suspected fracture* to the X rays, before and after setting.

The introduction of the X rays has shown us that fractures are more frequently present than we suppose. Many cases mistaken for sprains have been revealed as fractures in a skiagram ; and, in many instances, the timely application of the rays has allowed an unrecognized deformity to be rectified which if left would have seriously affected the patient.

4. In cases of doubt, unless there be some special contra-indication, administer an anæsthetic and examine thoroughly. It is not until all these investigations have been completed in an obscure case that the surgeon can say with confidence "There is no fracture."

Indications for Dressing and Treatment. — In the setting and treatment of fractures there are three main indications.

1. To get the bones into a position as near the natural as possible. Considerable force may be required for this, and therefore in most instances an anæsthetic should be given.

Reduction of any deformity will be effected by extension and counter-extension, i.e., pulling on the limb below the fracture, while the part above is steadied and held firm by an assistant. This pulling should be carefully performed ; its object is to overcome the muscular contraction which is producing the deformity.

Many fractures do not require this treatment. In fractures of bones of the face, manipulation only will be necessary. In fractures without displacement no formal setting need be undertaken (as in the case of some impacted fractures where the position is good). Measurements must be carefully made to see that all shortening has been overcome.

2. After the bones have been brought into as good a position as possible, some apparatus (*see* 'Splints') must be applied in order to keep them in that position.

3. Every effort must be made to restore the function of the part. Since with a fracture there is damage not only to the bones but also

to muscles and tendons, and often to nerves and joints, care must be taken in the after-treatment to see that these do not become useless from prolonged fixation. It is of little service to a patient to have perfect union between the ends of a broken bone if the nearest joint be locked and the muscles of the limb wasted and infirm. These accidents can be prevented by the early use of massage and passive movements.

While the above form the general rules on which fracture treatment should be carried out, there are certain other details which require attention.

The Best Time for Setting a Fracture is as soon as possible after the injury has been inflicted ; but if it has not been possible to arrive at a correct diagnosis, or if there be so much swelling that setting is out of the question, a few days must elapse before an attempt is made to get the fragments into apposition. *During this period of waiting the patient must be kept in bed.* Apply traction in cases of fracture of the lower extremity, attend to his general condition, and bear in mind that the course of a fracture is influenced by any constitutional disease, such as syphilis or Bright's disease.

Compound Fractures.—While ordinary or simple fractures are in themselves sufficiently serious, compound fractures are the worst injuries that one is called upon to treat. Not only is there a fracture present which requires its special treatment, but there is a lacerated wound, often contaminated with dirt and likely to suppurate, which interferes with the proper treatment of the fracture, and itself introduces a number of complications. Some fractures, in virtue of the position of the affected bone, are almost invariably compound, as in the case of a fractured jaw (these will be dealt with later). In the case of the extremities a compound is much rarer than a simple fracture, and usually requires more violence to produce it. A fracture of the tibia is often compound, owing to the subcutaneous position of the bone.

While the general rules formulated above are applicable to those fractures which are compound, much has to be said about the special treatment of these complex cases.

We may roughly divide compound fractures into three groups :—

1. The fracture is compound, i.e., the skin is broken, but no bone, or at most a small spicule, protrudes through the opening ; the wound is not obviously contaminated. There is no need to open up the wound ; in most cases it would be meddlesome surgery to attempt it. Apply an antiseptic dressing after carefully cleaning and shaving the skin round the opening, and treat as a simple fracture. If the edges of the wound become inflamed, and if the temperature rises, then it will be necessary to open up the wound thoroughly and drain.

2. Ordinary compound fractures, with laceration of the skin, frequently with comminution of the bones, and considerable contamination.

3. Bad compound fractures, with serious injuries to the soft parts,

joints being opened, muscles, vessels, and nerves torn, and the soft parts stripped up from the bone of the limb.

In this last group the question of amputation will have to be considered ; but as it is no part of a house surgeon's duty to decide this point, little will be said about the indications for performing radical operation. In most instances, however bad the injury, some attempt may be made to save the limb ; but in bad smashes of this nature, when the visiting surgeon must be summoned, it is very advisable for the house surgeon to obtain permission from the relations of the patient, or from the patient himself, for the performance of an amputation should the surgeon deem it advisable.

Treatment of Ordinary Cases of Compound Fracture.—As soon as the patient has reached the hospital he should be admitted to the ward ; the clothes should be cut off, if this has not been done already ; he should be packed round with hot bottles and well covered up. No prolonged examination should be made, and if a temporary splint has been applied satisfactorily it should not be removed until the patient has been anæsthetized.

It must be borne in mind that considerable shock accompanies a compound fracture, and undue exposure and unnecessary manipulations are to be condemned. Three points must be attended to. First, the fracture must be looked at, in order that some idea of the necessary treatment may be formed. Secondly, any serious bleeding must be checked by a tourniquet, or by other measures. Thirdly, any obvious complication must be looked for, i.e., other injuries—to spine, head, or abdomen, or to nerves in the region of the fracture. *It is well to be careful over this last point, since neglect of it may lead to a nervous lesion being overlooked when the patient is under an anæsthetic.*

Transfusion may be required.

When the patient has been anæsthetized, any remaining clothes are removed, and the temporary splint is taken off. The wound is lightly plugged with gauze soaked in some antiseptic (*see* later). Next, the skin all round the wound is washed and shaved ; if the tibia be fractured, the whole leg and foot should be treated in this way. The skin should be scrubbed with ether soap, and, after this has been washed off, with a solution of biniodide in spirit, 1–1000, or any strong antiseptic. Petrol is an excellent cleansing agent if ether soap is not available. Care must be taken during this stage that the wound is kept well covered up, so that the washings from the limb do not get into it. The limb being now rendered as far as possible aseptic, attention is directed to the wound and the fracture. The wound is washed out with saline, weak carbolic lotion, or other antiseptic, according to the opinions of the operator, and is then subjected to the following toilet. All ragged bits of skin are cut away from the edges, and the margins generally trimmed up with scissors ; if necessary the wound is excised with the knife. All dirt and foreign bodies are cleared away. A free irrigation with hot saline (120° F.) or some

selected antiseptic is the best for this purpose, but sharp spoons and forceps may be required. Any detached muscle, tendon, or fascia which may slough is cut away. All loose fragments of bone are removed, with any material that lies between the broken fragments. Any bleeding point or torn vessel (which may not be bleeding at the time) that can be seen is secured with a ligature. Any nerve or tendon that has been severed is united by direct suture of its two ends.

The bones are manipulated, with the assistance of extension and counter-extension, into the best possible position; occasionally, they must be plated. The responsibility of a decision as to whether an operation should or should not be undertaken rests with the visiting surgeon.

The wound is finally irrigated, and drainage tubes are inserted. As a rule few or no sutures will be required. Any incision that has been made can be sutured, but experience has shown that sutures inserted into bruised tissues are always harmful. A dressing is applied, and the limb is fixed on appropriate splints.

More modern methods of treating compound fractures have been evolved as the result of experiences in the war. Four varieties of treatment, which will be described in detail later, may now be mentioned as being suitable for cases of compound fracture in civil practice:—

1. Carrel's method. The immediate introduction of fine rubber tubes into the recesses of the wound so that it can be repeatedly filled with Dakin's solution—a solution containing hypochlorous acid, a powerful antiseptic.

2. B.I.P.P. treatment, which consists in rubbing into the wounded surfaces a mixture consisting of iodoform, bismuth, and paraffin.

3. Plugging with gauze soaked in flavine, which may be left *in situ* for several days.

4. Salt pack. Tablets of salt surrounded by gauze are packed into the wound.

All these methods will be considered later; but whichever method is selected, the systematic cleaning and proper toilet of the wound as described above are essential.

CHAPTER XV

ON THE AFTER-TREATMENT OF FRACTURES, AND THE MORE USUAL COMPLICATIONS WHICH WILL REQUIRE ATTENTION

THIS chapter will deal mainly with the after-treatment of cases of fracture which have been admitted to the wards, but as certain details demand attention in the treatment of fractures among out-patients, they will be considered first.

AFTER-TREATMENT.

All Fractures must be seen the day after the injury. At this, the first visit, the splints must be carefully inspected ; if they have slipped, they must be readjusted. The fingers or toes must be examined for swelling or numbness, and if these complications are present, or if the patient complains of severe pain, the splints must be taken off and the parts examined. The further treatment of uncomplicated cases consists in seeing the patient two, three, or four times a week, according to the nature of the injury, and in the regular performance of massage and passive movement. There should be no hesitation in 'taking a fracture down' ; in fact, within reasonable limits the more often this is done the better, since it gives the surgeon frequent opportunities of examining the part and correcting any deformity that may be present before firm consolidation has taken place.

The time that should elapse before the splints or other apparatus are dispensed with depends upon the nature of the fracture and upon the individual. Certain directions will be given later concerning special varieties of fracture, but we may say at once that some protection should be provided until all chance of re-fracture or bending of the callus is passed. It is wiser to prolong the use of splints than risk such accidents, since if the recommendations on massage and passive and active movements have been carried out, the use of splints for an additional week or two can have no injurious effect, and may often prevent the straining or bending of callus.

Complicated Cases, with special reference to Compound Fractures.—When the patient has been brought back into the ward from the operating theatre, it is the duty of the house surgeon to see that certain arrangements are made for his (the patient's) comfort.

If the limb is slung in a cradle it should be adjusted carefully, so that the splint swings free above the bed, and that all exposed parts are well covered up. Sometimes patients suffer a good deal of inconvenience from undue exposure.

A middle diet—fish or milk—should be ordered to start with, and it is always advisable to administer a purge to the patient the first night of his stay in the hospital. Confinement to bed causes sluggishness of the intestines in many people. The patient will probably require a sedative.

Although we appreciate the warnings uttered against a too free use of hypnotics, there is no reason for withholding them in cases of fracture, and a hypodermic injection of $\frac{1}{6}$ to $\frac{1}{4}$ gr. of morphia should be given in all cases of severe fracture unless specially contra-indicated. Not only does the patient pass a good night, but the spasm of the muscles is markedly diminished. The further treatment of these cases is similar to that advised above.

COMPLICATIONS.

Rise of Temperature is not uncommon the next day. The rise has been explained as being due to the absorption of blood extravasated round the fracture. It is probably due to tension, and the splints should be slightly slackened. In cases of compound fracture a rise of temperature of several degrees will be an indication of septic changes, but it must be remembered that such a rise is a gradual one, and it is not until the end of the second or third day that the symptoms of sepsis are pronounced, except in some rare fulminating cases. A rise of temperature on the day following the injury in cases of compound fracture makes us suspicious, but it does not necessarily imply sepsis. The case must be carefully watched.

Sepsis.—When this supervenes, the diagnosis will be easy. The temperature will rise to 102° or 104°; the wound will have become foul and sloughy, with considerable redness and surrounding œdema.

The wound must be thoroughly opened up, and free drainage provided, several counter-openings being made in dependent parts, and the dressings must be frequently changed. The best application is a fomentation (carbolic), or constant irrigation with very weak permanganate of potash or Dakin's solution. Sepsis is a very serious complication, and amputation may be required. This is a matter, however, for the visiting surgeon to decide, though much may be done by prompt and thorough treatment in the form of irrigation and counter-drainage. The general treatment of sepsis will be considered later.

Hypostatic Pneumonia commonly attacks old people, especially those who are somewhat emphysematous. It is more a congestion than an actual inflammatory process, and its onset is favoured by keeping these patients on their backs. The rule, therefore, in treating fractures in elderly people should be never to allow them to remain flat on the back; unless there is some very special reason to the contrary, they should always be well propped up with pillows. The first symptoms of this complication are usually cough, slight dyspnœa, and possibly some cyanosis and signs of consolidation at the lung bases.

Treatment.—Stimulants and expectorants must be given freely: brandy, $\frac{1}{2}$ oz., every three hours, or oftener if required. A good prescription is as follows:—

℞	Ammon. Carb.	gr. v	Tinct. Scillæ	♏xv
	Spiritus Ætheris	ʒss	Aq. Menth. Pip.	ad ℥j
	Vini Ipecac.	♏x		

Every four hours. (*Cheyne and Burghard.*)

As there is often cardiac failure as well as pulmonary congestion, both digitalis and strychnine are of great value. Strychnine is a respiratory stimulant and an expectorant.

As a rule a steam kettle is unnecessary, but if the bronchial tubes are clogged with a viscid mucus it affords relief. A pneumonia jacket may be applied. When the cyanosis becomes marked, venesection may be necessary, but we have obtained good results in these cases by dry cupping over the bases of the lungs. Inhalations of oxygen are of the greatest service, and should not be deferred too long.

Delirium Tremens is a form of mania occurring in alcoholic subjects. There are two distinct forms: (1) *The sthenic form*, where the patient is a robust, healthy individual, often plethoric, who has been accustomed to partake freely of alcohol without, perhaps, becoming very intoxicated. (2) *The asthenic form*, which occurs in broken-down alcoholics whose tissues are unhealthy and whose constitution has been undermined. There is little doubt that a patient suddenly deprived of stimulant of which he has usually partaken freely is liable to an attack of delirium tremens, which may be aborted by the judicious administration of alcohol; such cases should be allowed small quantities of their usual stimulant, and it is of great importance to find out from the patient what his habits have been previous to his admission.

The earliest symptoms of delirium tremens are restlessness and inability to sleep. This is an additional reason for the administration of some hypnotic the first night after admission, for delirium tremens can sometimes be prevented in this way. Soon the restlessness gives place to tremor, twitchings, and to hallucinations (tremor of the tongue and hands is an early and valuable sign); the patient becomes delirious, violent, and maniacal; he throws himself about, moves his fractured limb, apparently without pain, and unless watched may get out of bed. When these symptoms have appeared, there are four special points to be attended to:—

1. The patient must be made to sleep. Many hypnotics have been recommended, but chloral 10 to 15 gr., with a similar quantity of bromide of potassium, appears to us the best. Chloral, it is true, is a cardiac depressant, but trional and sulphonal often fail. Morphia should be avoided.

2. The patient must be fed. In the sthenic type this is not important—there is violent delirium, the temperature is high, and the

pulse full and bounding ; but in the asthenic variety the patient will require careful feeding with a stomach or nasal tube if he refuses to swallow ; stimulants should be given if he is much exhausted.

3. A brisk purge should be given.

4. The fracture must receive attention. The best way of controlling the fracture is to put it up in plaster. If this cannot be done owing to the violence of the patient, he must be anæsthetized until the casing has been made. If this treatment is not possible, the limb should be slung, and any damage done to the fracture should be rectified afterwards. An attendant will be necessary, and the patient may have to be strapped down in bed.

Before leaving this subject, it should be noted that *mental disturbances* of various forms, apart from delirium tremens, are by no means uncommon during the treatment of fractures and other surgical cases. When the peculiar conduct of a patient arouses the slightest suspicion in the mind of a house surgeon, he should *at once* notify the authorities and take every precaution for keeping the patient under observation. In this way such accidents as patients throwing themselves out of windows, or making murderous assaults on other inmates of the ward, can be prevented.

Thrombosis is a fairly common complication. It may result from damage inflicted on the vein at the time of the original injury, or from inflammatory changes occurring later. It is recognized by swelling of the limb below the thrombus, and by pain and tenderness ; sometimes a definite thickening over the course of the vein. Thrombosis must be regarded seriously : gangrene may be caused by it ; while other accidents, such as embolism, may arise from this condition.

Gangrene is recognized by discoloration of the limb below the fracture, and by loss of sensation and warmth. It is usually of the moist variety, and demands amputation.

Involvement of Nerves in Callus must be borne in mind, and any case which shows symptoms of this complication should be at once reported to the visiting surgeon.

Bedsores are to be avoided by careful attention to the points mentioned later (*see* ‘ Bedsores ’).

Mal-union and Non-union may occur in spite of the most careful treatment. As soon as they are noticed, unless the house surgeon can remedy the condition, the visiting surgeon should be informed, since an operation may be advisable.

Ischæmic Paralysis, or Volkmann’s contracture, usually found in the upper extremity, is probably due to two factors, damage to the muscles and tight splinting ; sometimes also nerves are damaged. If care is exercised in the treatment of fractures, it is unlikely to occur. It is recognized by a peculiar claw-like contraction of the hand and forearm after an injury to the bones.

Other rarer complications are not here considered.

CHAPTER XVI

FRACTURES OF SPECIAL BONES

THE BONES OF THE FACE.

FRACTURES of the Nasal Bones are common enough in surgical practice, and a lifelong disfigurement is the result of neglecting to remedy the displacement. In these injuries either the nasal bones themselves, or their cartilages, or the septum narium, or all of these structures, are displaced or broken. The first point to bear in mind is that the sooner the parts displaced are put into position, the better and easier that restoration will be. The swelling may be very troublesome ; to reduce it hot fomentations will be found most useful. Leeches have been recommended, but for obvious reasons they can be used only very sparingly to the outside of the nose.

The line of treatment is in most cases a simple one. The displaced or depressed bones must be lifted into place again by manipulation with such an instrument as a stiff steel director or a pair of bone forceps inserted into the nostril ; once replaced, they will generally remain in position ; if not, they must be kept there by plugs of lint or gauze, soaked in carbolized oil or soft paraffin.

Displacement of the Cartilages is more obstinate than that of the bones, and generally requires careful plugging with pledgets of lint, frequently changed, to cure the deformity. This is especially true of displacement of the septum, causing obstruction to the respiration through one nostril and catarrh of the mucous membrane. In these cases the septum must first be straightened with an ordinary pair of dressing forceps, or, if they are at hand, with the flat-bladed forceps invented by Adams, and should then be kept in its place by suitable plugs.

All attempts at moulding by pads, lint, etc., placed outside the nose, appear to be useless, but a carefully moulded guttapercha 'cap' is often very serviceable.

Other fractures of the bones of the face, e.g., of the zygoma or the malar bone, occur so rarely in practice, and differ so widely in every case, that it would be but lost labour to lay down any general rules of treatment.

THE JAWS.

Fracture of the Lower Jaw is very common, and occurs with very varying degrees of severity. Those cases will first be considered which may be treated satisfactorily by the general surgeon, who does not claim to possess the special manipulative skill which belongs

more properly to those who have given particular attention to the surgery of the teeth and of the parts connected with them.

An ordinary fracture of the jaw occurs from direct violence, and is *frequently compound.* Provided that necrosis does not take place, this fact does not materially alter the process of union, or the treatment, and the fragments as a rule unite firmly enough.

In most cases it will be sufficient carefully to mould a *guttapercha or plastic felt splint* to the outside of the jaw, as shown in *Fig.* 85, and to fix it with a firm four-tailed bandage (*see also Fig.* 43), so that the upper teeth may fit to the lower ones, and thus serve as a natural splint.

The moulded splint should be fashioned out of an oblong piece of guttapercha or felt, about 10 in. by 5 in. for an adult man (the size will, of course, vary), and must be cut down the middle of its length, except for about three inches in the centre, so that it is of the shape of the centre of the four-tailed bandage which has been before described. To mould and apply it the four ends thus made must be folded up while it is warm exactly as the bandage is. It will be wise to cut out a paper shape first, to secure an exact fit. If it be necessary, as for the dressing of a wound on the chin, a trap-door may be cut in the splint.

Fig. 85.—Moulded Splint for Lower Jaw.

In more severe cases, additional firmness may be attained by *fastening together the unloosened teeth* on either side of the fracture *with a stout silver wire*; this with care is often of great service. Again, a rough interdental splint may be made by warming and moulding a mass of guttapercha of about the size of one's thumb, and pressing up the teeth on the side of the fracture into it, and when the fragments are in good position, pressing the whole mass upwards against the upper teeth.

Loosened teeth should always be left alone unless they are obviously shattered. For the first week or ten days all food must of course be liquid, and for the first day or two it will generally be found possible to get nourishment enough taken through a tube, or poured in at the corner of the mouth. But the patient will soon manage to suck in and swallow fluids, and later on soft semi-solid food, without disturbance of the fragments.

Fractures of the jaw of ordinary severity, and which do not present unusual complications of displacement, may be successfully treated on the foregoing lines. Cases, however, will present themselves which require special apparatus and special mechanical knowledge to keep the fragments in good position. During treatment the mouth must

be repeatedly washed out, as food readily collects in the buccal recesses (*see* 'Post-operative Treatment—Pulmonary Complications'—Section XI.)

SEVERE FRACTURES OF THE JAW REQUIRING SPECIAL APPARATUS.

Fractures of the Lower Jaw.—Until 1816 no advance was made upon bandaging as a means of keeping steady the broken ends of the lower jaw. About that time Malgaigne, Lonsdale, and others suggested the plan of tying together the teeth near the fracture with silk or wire, or of boring holes in the alveolus on either side of the fracture, and then tightly twisting up wires passed through them.

The next distinct advance in this direction was due to Lonsdale, who employed an apparatus with a concave semicircular ivory groove to receive the teeth; this was fixed to a curved screw-bar, so attached to a lower padded chin-piece that by the screwing up of a nut the front teeth (if any were present) were tightly pressed on their cutting edges, and the jaw pressed up to the teeth. The chief objection to Lonsdale's splint has been its liability to catch in the bedclothes and to be dragged out of position during sleep, and in any case a splint made on this principle would not be comfortable or trustworthy for mouths which were edentulous, or where molar teeth only existed.

Nevertheless, for cases of great displacement, especially if the fractures are compound, metal cap splints can be made (generally vulcanite is used) which are able to fit the teeth and gums and keep the fractured ends of the bones and teeth (if any) in absolute apposition, and the jaws in normal coaptation; but for this treatment to be successful the obtaining of an accurate model is a *sine qua non.*

Methods of Modelling.—There are two ways in which an exact model may be proeured.

If the fractured bone can be held in accurate position while the model is taken in wax carried in a well-selected dentist's impression-tray such as is used for modelling for artificial teeth, an impression may be easily and quickly made which will do quite well; but if there is much displacement or comminution, or if the jaw presents much swelling or tenderness, the forcible retention of the displaced parts long enough in position to secure a good mould is not possible, and the second plan must be resorted to.

This consists in taking a model of the displaced bone *as it is*, and then altering the cast from it by sawing it in pieces and again uniting these in their proper position. When the teeth are fairly numerous in both jaws, this task will be rendered much easier from the guides which the faceting of their worn surfaces will afford.

The fragments thus coapted may be retained in place with melted beeswax, and then a solid plaster-of-Paris mould may be made, upon which dies and matrices may be cast, on which vulcanite plates can be moulded.

To fit all the teeth and the gums for about one-third to half an inch below the teeth on the tongue and lip side, this cap should extend back so far as to fit over at least the farthest back tooth which is embedded in a misplaced piece of jaw. If the fracture be compound, several holes should be drilled in the plate in those situations where the discharge takes place.

It is often sufficient to place this cap or plate in the mouth, and steadily press up the teeth into their proper receptacles, and then to bandage outside with the usual 'four-tailed' bandage over a well-fitted guttapercha socket, made to the horizontal ramus of the jaw after it has been set. The chief advantage of a metal plate is the comparatively small space it occupies in the mouth (*Figs.* 86, 87); it soon ceases to stimulate the salivary glands.

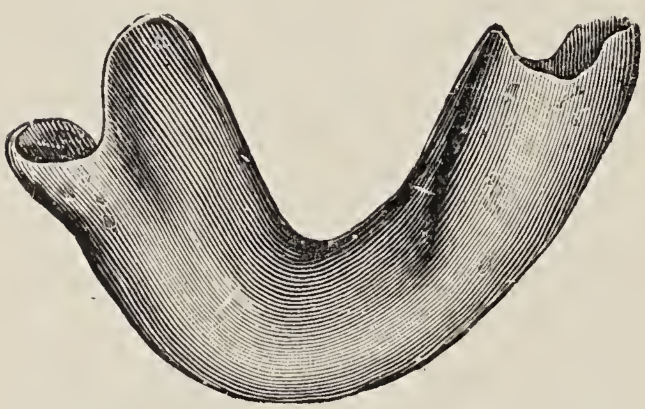


Fig. 86.—Metal Cap Splint for Fractured Lower Jaw, seen from above.

In order to dispense with the four-tailed bandage, which keeps the jaws closed, metal arms of stout wire may be affixed to such a plate as is described above. These are brought out at the angles of the mouth and directed horizontally backwards. Turns of a bandage passed from one arm to the other beneath the mandible complete a splint which permits the patient to open the mouth. Hammond's wire splint allows of the same comfort, and can be used where a sufficient number of teeth are standing. A stout piece of iron wire is so bent as to follow the indentations of the necks of the teeth on both inner and outer surfaces. The two ends are soldered together. The splint is placed over the crowns of the teeth. Small pieces of fine iron binding wire are then passed between and around several teeth, being directed under and over the inner and outer portions of the splint. The ends of the binding wire are twisted up, tightened, and tucked out of the way. This splint is a very serviceable one, but it should always be applied by a dental surgeon.

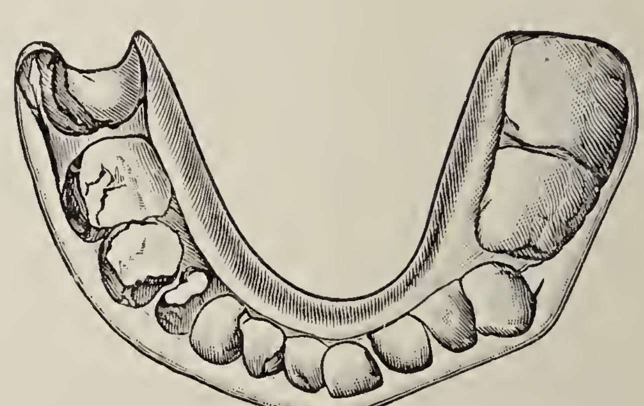


Fig. 87.—Metal Cap Splint for Lower Jaw, seen from below.

In some cases splints have to be made and fitted to each jaw, and when the correct coaptation has been secured, the two pieces can be joined together by vulcanite, leaving spaces for tubes for feeding and for the use of antiseptics. Guttapercha, or gum resins, may be used

as temporary interdental splints very conveniently, particularly in young persons.

Fractures of the Upper Jaw, with or without broken or displaced teeth, are of much more frequent occurrence in civil practice than formerly, due chiefly to the development of football, cricket, cycling, and motoring.

The treatment of such cases is similar to and simpler than that of fractures of the lower jaw, as there is a fixed basis for an interdental splint, or one fitting only to the teeth, gums, and hard palate. The greater vascularity of the bones and soft tissues is an immense advantage, and for this reason any portions of bone having the smallest attachment to soft parts should be replaced in their normal situations; also, teeth whose fangs are broken from their sockets, or those entirely detached, should be replaced after being thoroughly cleansed in warm water and the coagula removed from their sockets. The recuperative power of the vascular tissues is so great that the most determined effort should be made to avoid the sacrifice of any part of the jaw, alveolar process, or tooth which has any soft tissue connection. It is therefore especially important to replace the disturbed bones and teeth as soon as possible. Care must be taken if there is comminution not to pinch any soft parts between the broken fragments in replacing them, otherwise much pain, swelling, and delayed union will result.

When the fragments have been satisfactorily replaced, a vulcanite, guttapercha, or gum-resin splint, or a metal splint lined with guttapercha or vulcanite, modelled as already described for a fractured lower jaw, may be fitted.

THE CLAVICLE.

It is stated by statisticians that fracture of the clavicle stands fifth in the order of relative frequency, but it is probable that its real place is higher ; the error (if error it be) having perhaps arisen from the tables being largely drawn from in-patient records, while the majority of these fractures are treated in the casualty rooms of hospitals, and may never come upon their books. Moreover, it is certain that in infants the fracture is often not recognized or treated at all.

At any rate the injury is exceedingly common, and every student may count upon seeing a sufficient number of cases. Yet there is no fracture about the setting of which text-books give more bewildering and contradictory directions.

The great points of difference are, first, as to the position of the arm, and especially of the elbow ; second, as to the use of an axillary pad ; third, whether some set form of apparatus, or strapping, or bandaging is best.

Leaving unconsidered the various questions as to the treatment of complex clavicular fractures which may arise in particular cases,

the methods commonly employed for setting the ordinary examples of the fracture are here described.

In the first place, there is probably only one way in which the fracture can be so treated that there shall be no permanent deformity, and that is by compelling the patient to *lie absolutely flat and still*, with a small cushion between the shoulders, until there is sufficient cohesion of the fragments to prevent any displacement. For this at least a fortnight will be required, and no bandage or apparatus of any kind is called for so long as the position is maintained, for the fragments come naturally into their places.

This treatment may be supplemented by an axillary brace or by a padded splint and bandage. The axillary brace consists of two loops of soft bandage material or skeins of wool, which are passed round the axilla on each side ; they are secured at the back by a broad strap with a buckle (care being taken that the buckle does not press against the skin). By means of the strap the two skeins are drawn tight and the shoulders brought well back.

The second method consists of placing a well-padded splint (*see Fig.* 35, p. 75) in the middle of the back, reaching from the seventh cervical vertebra to the mid or lower dorsal region, and applying a double spica.

The Deformity to be rectified in the case of the common *Fracture in the Middle Third* is, when the patient is erect, a downward, inward, and forward displacement of the outer fragment ; the shoulder therefore requires to be elevated and to be pressed outwards and backwards ; and to fix the parts in this position the arm must be fastened to the side.

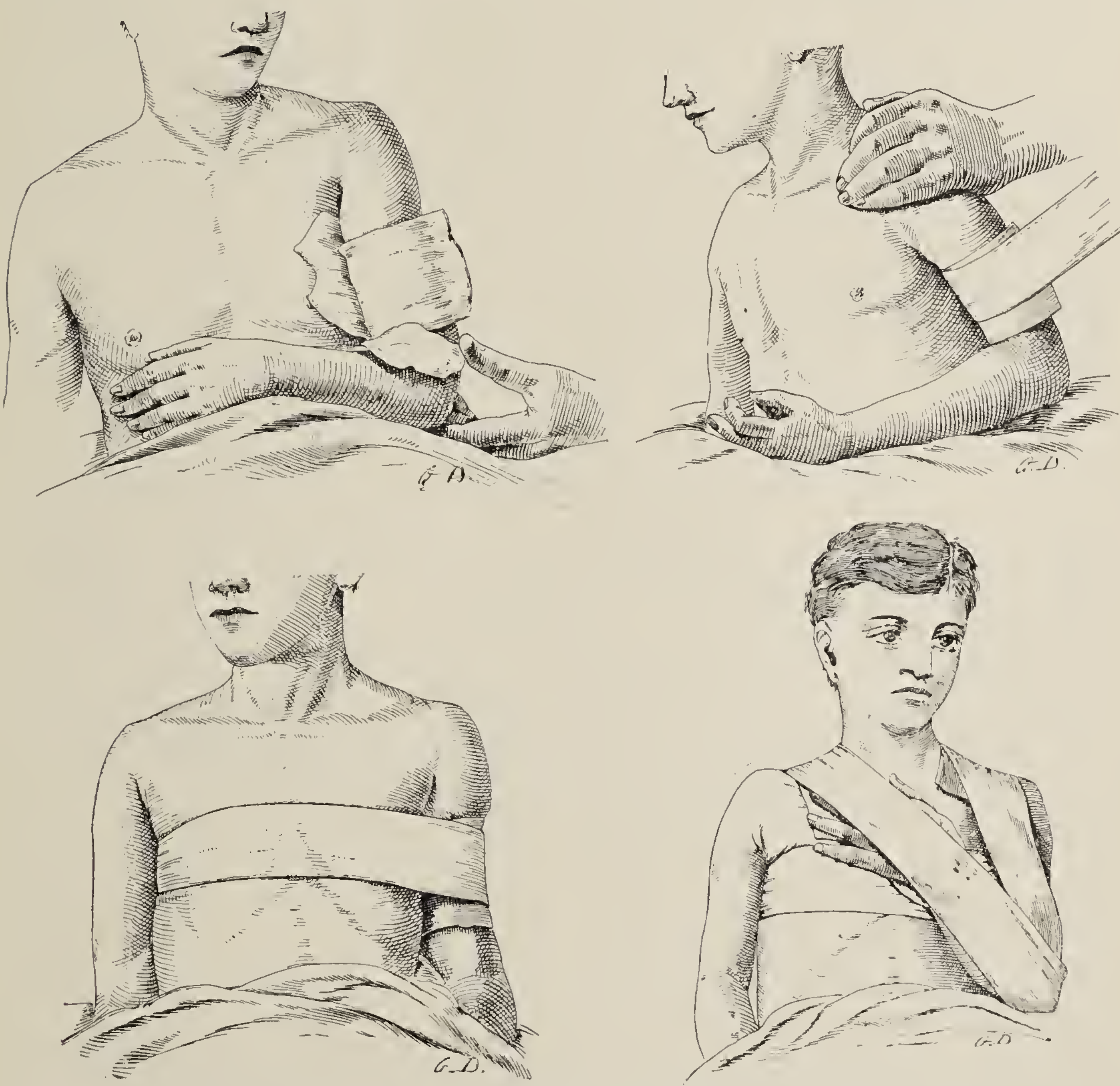
In Infants and very young Children, incomplete fractures of the clavicle are very common, and are easily overlooked. It is almost hopeless to try to follow any fixed rules as to the setting of these fractures, but they generally unite with little deformity if the arm be brought to the side, the forearm and hand crossed over the chest, and the limb fixed in that position by strips of adhesive plaster (a baby will wriggle out of any ordinary bandage in ten minutes) ; all precautions being taken to avoid chafing of the skin.

For the more infrequent fractures which involve the *inner* or the *outer extremities* of the clavicle, it is difficult to lay down any general rules of treatment. It may first be said, that in all cases where there is much displacement, the fracture should be put up on the same lines as if it were one in the middle third. If, however, the fracture be quite close to the sternum, any bandage which will confine the arm to the side and the hand and forearm across the chest, for a fortnight, will suffice.

If again the fracture be near the acromion, and there is not much displacement, a shoulder cap of guttapercha or felt, as in fractures of the neck of the humerus (q.v.), will be an efficient mode of treatment. Axillary pads in these last cases are not generally required.

Treatment by broad Strips of Adhesive Plaster is a plan introduced by Sayre, which is now in very general use in this country.

The principle and practice of this method will be understood from *Figs.* 88 to 92. The limb should be washed and shaved, the axillary hairs be cut short, and the whole area well powdered with boric acid and starch. Two strips of adhesive strapping are cut, three to four inches wide, and of sufficient length. The arm being held in



Figs. 88, 89, 90, 91.—Sayre's Method for Fractured Clavicle. (Front.)

position, one piece is first fastened round it, just above the centre, and secured by a few stitches ; the strip is then carried backwards round the body, and fixed to the first part. The second piece is carried downwards from just behind the uninjured shoulder and obliquely across the back, the point of the elbow is received in a slit, and the strapping is then carried up over the forearm and hand, which are flexed on the chest, and fastened at the place it started from. Sayre does not use an axillary pad, but if it improves the position it should be employed.

The principle of Sayre's method is as follows: By means of the first turn of strapping the arm is fixed, and the strapping forms a fulcrum on which the arm may be moved. The first piece of strapping is applied with the point of the elbow directed backwards. Before the second piece of strapping is adjusted the point of the elbow is brought forward, and the first strapping acting as a fulcrum, the shoulder is carried well back and the deformity is rectified. A third piece may be employed to keep the fragments in place (*see Figs.* 91, 92).

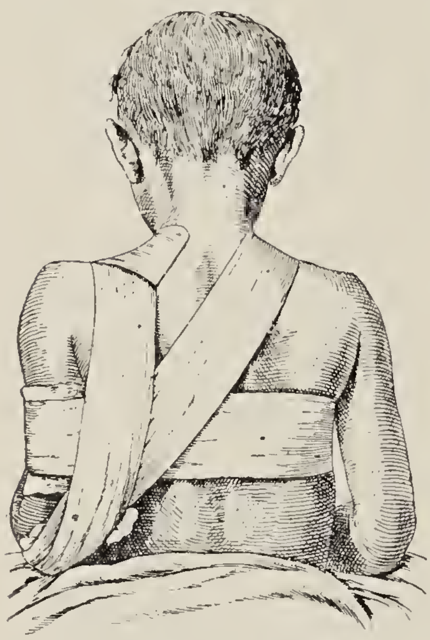


Fig. 92.—Sayre's Method for Fractured Clavicle. (Back.)

After-treatment.—This appliance is kept on for three weeks, but it may require changing several times, as it is apt to get loose. Massage should be begun at once. (Ellis's splint (*Fig.* 93) is a satisfactory apparatus which can be substituted for Sayre's method.) If an axillary pad is used, care must be taken that it does not press on the axillary vessels. After three weeks the strapping may be removed, but the arm must be kept in a sling or protected by a bandage for two to three weeks longer. As a general rule five to six weeks must elapse before the patient is ready for ordinary work.

Fractures of the acromial and sternal ends are treated similarly. When the fracture lies between the conoid and trapezoid ligaments there is no displacement; a bandage and sling are usually sufficient. If the line of fracture lies external to these ligaments, Sayre's method *without backward traction* should be used.

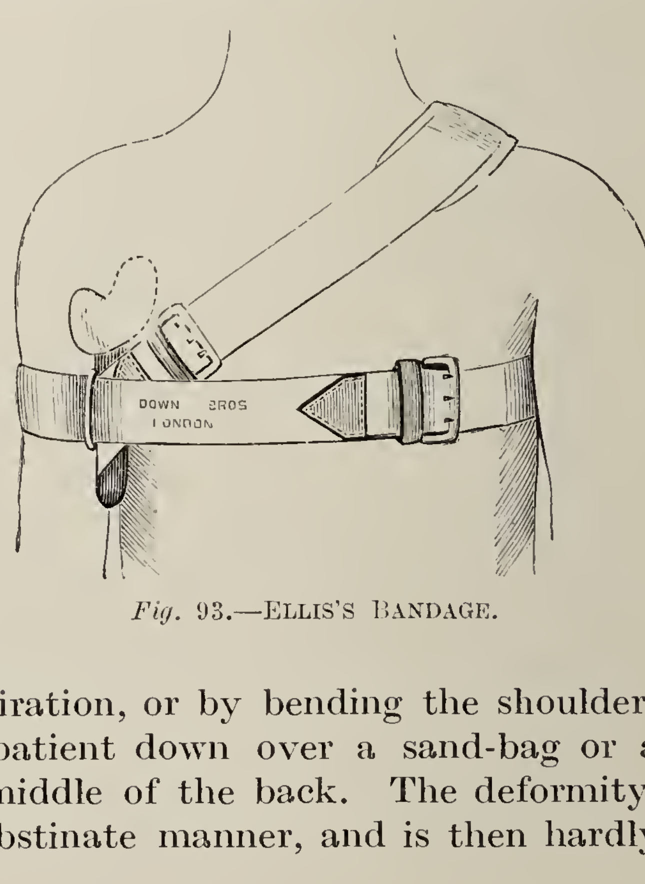


Fig. 93.—Ellis's Bandage.

THE STERNUM AND RIBS.

Fractures of the Sternum are rare, but may occur in consequence of direct or of indirect violence. Care must be taken, in examining the thorax after injury, not to mistake some congenital or acquired incurvation of this bone for a fracture. The displacement, if there be any, can often be reduced by making the patient take an inspiration, or by bending the shoulder-blades back, or by laying the patient down over a sand-bag or a wooden block placed under the middle of the back. The deformity, however, is apt to recur in an obstinate manner, and is then hardly

amenable to treatment. In the course of time the parts will often come of themselves into fair position, so that they may be left alone, unless, as sometimes happens, an embarrassment of breathing calls for special operative treatment. In ordinary cases, the ends being brought into as good position as may be, all that is required is a broad calico or flannel roller, applied as for broken ribs, or the double spica of the shoulders may be applied (*see Fig.* 35).

Fractures of the Ribs require widely different treatment according to the nature and the extent of the injury.

Taking the ordinary cases first, it will be found that the patient has been badly squeezed in a crowd, or has been run over by a light cart, or has suffered some similar injury. He complains of a catching stitch or stab on inspiration ; he leans forward, and holds his breath as much as possible, and quickly learns that by pressing his hands to his sides the pain and difficulty in breathing are lessened. On examination of the seat of pain (probably about the seventh or eighth rib), by firm pressure (*Fig.* 94), crepitus and mobility may often be detected, but this is by no means invariably the case, especially in

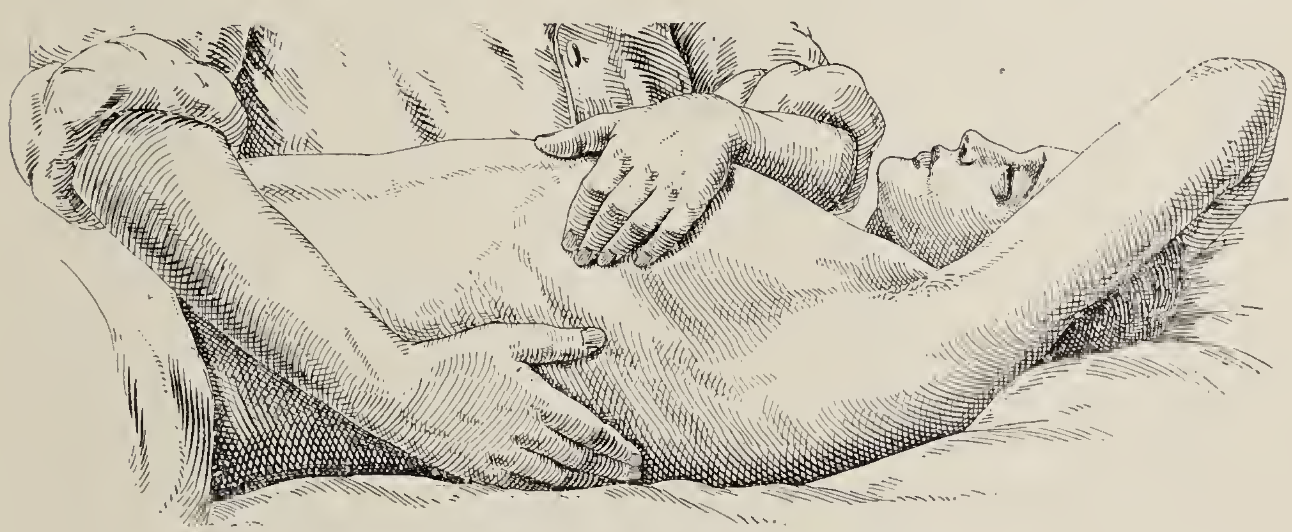


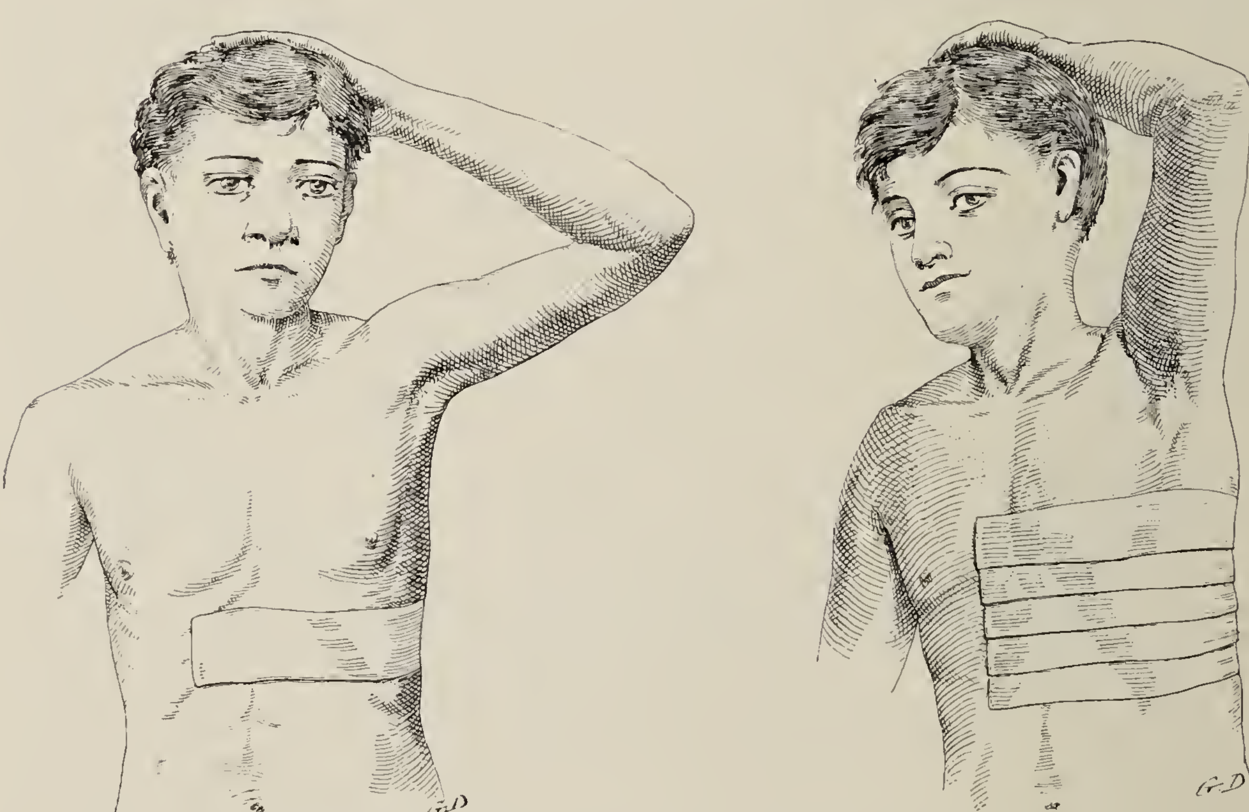
Fig. 94.—Examination for Fracture of the Ribs.
(Patient should always be lying down.)

fat people. The stethoscope will frequently detect the crepitus when the sense of touch fails to do so; but, in any case, a sufficient injury, followed by symptoms such as the foregoing, gives presumptive evidence of one or more ribs being cracked or broken, and it will always be safe to treat the patient accordingly.*

In such a case, one, two, or three ribs may be broken, but they are still retaining tolerably firm relations with their fellows ; the pleura is but slightly injured, and there is practically no displacement. Firm pressure on the thorax restrains the play of the ribs, and thus the source of pain is avoided.

* The post-mortem table teaches us how often, in cases of accident, fractures of the ribs are overlooked in the presence of other and more obvious injuries.

For these reasons it is advisable to confine the play of the ribs by the application of strips of adhesive strapping somewhat obliquely round the chest (*Figs.* 95, 96). Linen strapping is commonly used ; it should be cut into strips $1\frac{1}{2}$ inches wide, and long enough to be within three inches or so of meeting in front. The strips should be applied successively from below upwards, starting at the floating ribs. The surgeon, standing in front of the patient and applying the centre of the strip to the middle line behind, should bring the two ends, evenly and firmly, forwards and somewhat upwards, so as to compress the chest walls from behind forwards *during expiration.* The strips should overlap about half an inch, and they should be continued, as a rule, up to the third or fourth rib. Over the strapping a flannel or any ordinary bandage should then be firmly rolled, as shown in *Fig.* 44 ; this may be prevented from slipping down by the brace



Figs. 95, 96.—Application of Strapping to Fractured Ribs.

shown in the figure, which is simply made by tearing a hole in a piece of broad bandage and putting the head through it, so that it hangs down in front and behind. The bandage is put on outside this brace, the ends of which are then turned up and fixed.

When the injury is less severe, it may be unnecessary to apply the strapping, a firm bandage being all that is required. In any case the patient will probably be unable to lie flat down in bed for some days. But the foregoing rules of treatment will have to be greatly modified or abandoned in the more serious cases where there is *severe injury to the lungs*, or great crushing of the thoracic walls ; such an injury, for example, as that which the direct kick of a horse may inflict, where the rib, instead of being bent outwards until it

breaks, is forcibly driven into the chest cavity ; or where the whole chest wall may be crushed out of shape, and its bellows action almost or quite abolished. In such a case the dyspnœa will be extreme ; the symptoms of hæmo- or pneumo-thorax may quickly develop, with surgical emphysema, and hæmoptysis will almost certainly be present.

Under these circumstances it is clearly unsafe to put any further restrictions on the processes of oxygenation ; indeed, no tight bandage or strapping would be borne by the patient for one minute ; all that can be done locally is to give a gentle support to the chest walls with a broad flannel roller. If one of the broken ends remains permanently depressed, efforts may be made by manipulation to elevate it ; it has been suggested that the end of the portion which has retained its position should be depressed to the level of the other, in order that the two fragments may interlock, when the spring of the undisplaced end may raise the other with it. The employment of any instrument to forcibly raise up the fragment cannot be recommended, for it is well known that this displacement tends to rectify itself by degrees, as with recovery freedom of respiration advances.

The *Hæmoptysis* is not generally dangerous in itself, but should be watched anxiously in consequence of the pneumonia which is likely to develop in the area of injury. If this occurs there is a very serious increase in the embarrassment to the breathing, and great engorgement of the right side of the heart, evidenced by a quick hard pulse, and partial asphyxia. In such conditions, recourse must be made to drugs, and considerable relief may be experienced by bleeding the patient, which will temporarily, if not permanently, relieve the engorged right side of the heart. The good effect of taking away seven or eight ounces of blood is often most striking, and might be with advantage more frequently employed. The method of performing the operation of bleeding is described later.

With regard to the *Surgical Emphysema*, it is rare for it to be a serious embarrassment, although it has sometimes, by spreading beneath the deep cervical fascia, caused difficulty in breathing or swallowing. It is best left alone, or controlled by bandaging only ; but if it must be diminished—and cases are on record in which the features of the face were obliterated, and the whole body was blown out—small punctures may be made, or, better, 'Southey's trocars' may be introduced into the cellular tissue, the ensheathing cannulæ, which must be previously boiled, being allowed to remain *in situ*.

All cases of fractured ribs complicated by hæmoptysis and surgical emphysema are to be admitted into the wards.

INJURIES IN THE NEIGHBOURHOOD OF THE SHOULDER-JOINT.

Injuries in the region of the shoulder-joint are often very difficult to diagnose, on account of the swelling of the parts and owing to the manner in which the various injuries mimic one another. In the

following account an attempt will be made to explain how a routine examination of the shoulder region should be made, and a list will be given of the more common forms of injury likely to be met with.

The student is strongly advised to take every opportunity of examining the bony landmarks round the shoulder (*Fig.* 97) and other regions described later. By this means alone can he appreciate the departures from the normal which are met with as the result of injury.

Suppose that a stout, elderly man has fallen on to the region of his shoulder ; there is a considerable amount of swelling. The first region to be examined is the clavicle—the bone is subcutaneous, and can be felt along its whole length ; any deformity, irregularity, or painful spot is to be noticed. Fracture between the conoid and trapezoid ligaments shows no deformity, gives no crepitus as a rule, and is diagnosed by a point of acute tenderness above the coracoid process.

Excluding injury to the clavicle, both shoulders are to be carefully inspected, with the patient in a good light facing the surgeon. Note the presence or absence of bruising or of flattening of the shoulder.

Flattening of the shoulder is seen in dislocation, in fracture of the surgical neck of the scapula, and, to a less extent, in fracture of the upper end of the humerus.

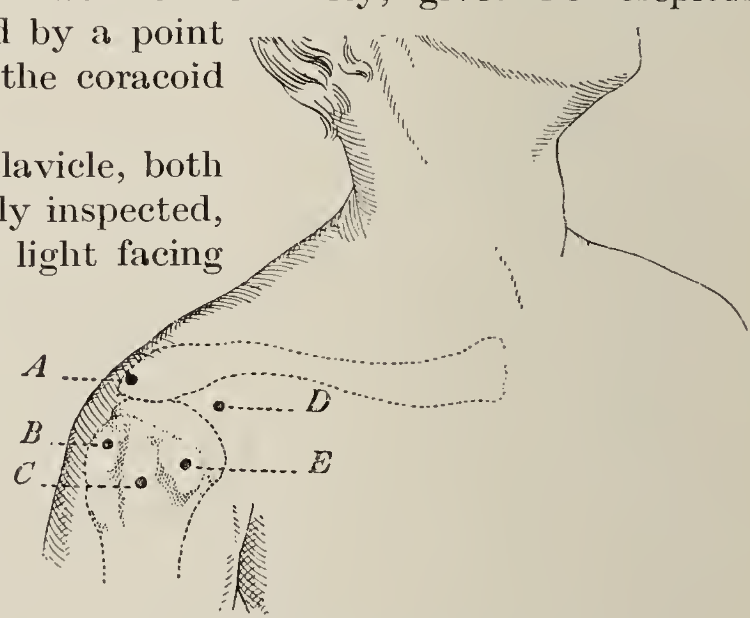


Fig. 97.—BONY POINTS TO BE NOTED IN THE REGION OF THE SHOULDER-JOINT :—
A. Tip of Acromion Process. *C.* Bicipital Groove.
B. Great Tuberosity. *D.* Coracoid Process.
E. Lesser Tuberosity.

The presence of flattening after receipt of an injury is of value, but its absence must not mislead the observer, since when much swelling is present it may not be marked.

Next look for any abnormal protrusion or swelling apart from the general effusion. Careful inspection in cases of dislocation will nearly always show an abnormal fullness below the coracoid process. Notice the position of the arm. In dislocation it is held away from the side and is fairly rigid, and if the previous swelling caused by the head of the bone has been noticed, the long axis of the arm will be found to be directed towards it. In fracture of the surgical neck the arm may be held away from the side, but there is no swelling beneath the coracoid process.

Now proceed to palpation and manipulation. Feel for the outer extremity of the acromion process, and press the fingers inwards beneath it in the direction of the great tuberosity. Compare carefully with the opposite side. If the fingers dip in more deeply on the

injured than on the sound side, *the head of the bone has been displaced.* This displacement is caused by dislocation, and to a less extent by fracture of the surgical neck of the scapula, and sometimes by fracture of the anatomical neck of the humerus.

Place the hand in the axilla and feel for any abnormal bony prominences, again comparing with the sound side. Such abnormal prominences are met with in fracture of the surgical neck of the humerus, when the upper end of the lower fragment is drawn into the axilla, and in fracture of the anatomical neck of the humerus, when the displaced head can sometimes be felt.

Grasp the elbow with one hand and the shoulder with the other, and rotate the arm gently. If the great tuberosity can be felt to rotate, either a fracture of the neck is absent or, if present, it is impacted. If this rotation is accompanied by crepitus (the great tuberosity moving with the shaft), there is probably a fracture of the anatomical neck of the humerus.

Next see whether slight manipulation—pushing up of the elbow, and drawing back the shoulder—will obliterate the deformity : if this manœuvre does so with crepitus there is fracture of the neck of the scapula.

Lastly, measure the arm from the acromion process to the olecranon or external condyle. In a case of severe injury to the shoulder with much bruising and no apparent displacement, definite shortening is a sign of an impacted fracture.

It may not be possible, even after the most careful examination, to come to a definite conclusion, and more than one injury may be present. In these circumstances the patient must be put to bed, and some form of temporary apparatus (sling and bandage) should be applied ; in all cases a good X-ray photograph should be taken, as it is essential to accurate diagnosis.

General Points in Treatment.—Before any strapping or bandages are applied, it is always advisable to wash the parts, remove the hair if it can be done without causing much pain, and powder the axilla and shoulder with boric acid and starch. The condition of the radial pulse must be noted, since the artery may have been injured. Numbness and tingling denote damage to the brachial plexus. An axillary pad will often cause pain and swelling ; if this is so it must be removed at once. *The abducted position is the 'position of choice' for all injuries to the shoulder.*

Severe injuries to the shoulder, especially dislocations, often cause damage to the circumflex and suprascapular nerves ; this should be remembered, and if marked wasting of the deltoid is noticed during the after-treatment, no time should be lost in testing the electrical reaction of the muscles, and if the nerves are injured, adding galvanism to the necessary massage and movement. 'Sayre's method' is applicable to fractures of the clavicle and scapula, and gives good results. In all fractures in the region of the shoulder-joint a shoulder cap of poroplastic felt should be fitted (*Fig.* 98).

Fractures of the Scapula.—Only three varieties of fraeture of the seapula will be eonsidered : (1) Fraeture of the body, usually produeed by erushes or severe blows ; (2) Fraeture of the neek of the seapula ; (3) Fraeture of the aeromion proeess.

The diagnosis of these injuries may be very diffieult, and no definite opinion ean be given in many eases until an X-ray photograph has been taken.

1. *Fracture of the Body* is the most readily recognized. It is treated by paeking the seapular region and the axilla with wool, after the skin has been powdered with boraeie aeid and stareh. A broad bandage is wound round the shoulder and axilla of the affected side, and the arm is bandaged to the side. The patient should be kept in bed for three weeks. Injuries to the ribs are usually present.

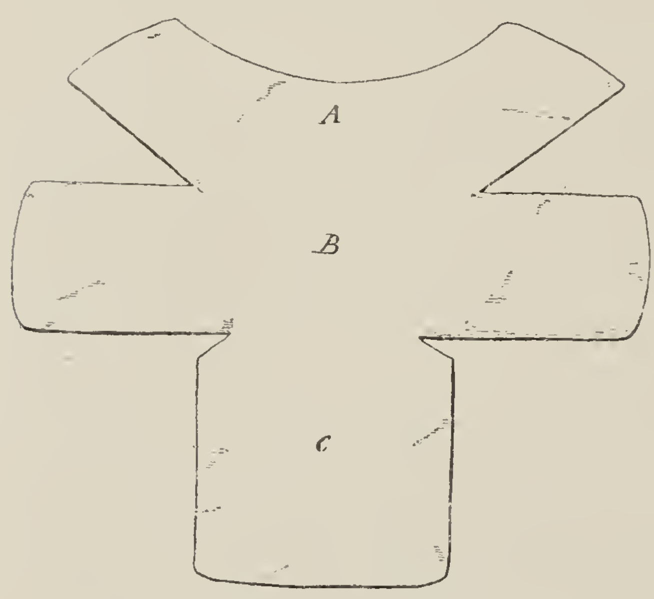


Fig. 98.—Outline of Poroplastic Cap for Shoulder, which should be moulded into position : *A*, Collar ; *B*, Chest-piece ; *C*, Armlet. In cases where the shaft of the humerus is broken, the armlet should be made much larger, so as to include the whole arm and elbow.

2. *Fracture of the Neck* of the seapula may be treated by a pad in the axilla and a broad bandage round the arm, with the objeet of supporting the elbow and preventing the seapular fragment dropping down, as it has a tendeney to do. 'Sayre's method' is as good as any.

Massage must be begun at onee, and passive movement at the end of a week, the fractured region being steadied by a hand in the axilla. Bandage or strapping should be retained for six weeks, and eomplete reeovery of function expected at the end of seven or eight weeks.

3. *Fractures of the Acromion Process* are diffieult to deal with : the action of the deltoid drags the fragment down. The best treatment is 'Sayre's method' without an axillary pad, the humerus being used to push up the detaehed fragment. The retentive apparatus should be applied for one month.

Fractures of the Humerus.—The following fractures will be considered here : (1) The anatomieal neek ; (2) The surgieal neck ; (3) The shaft above, and (4) The shaft below the deltoid insertion.

1. *Fracture of the Anatomical Neck* oceurs in elderly patients, as a rule from direet violenee. Considerable bruising and shock are present, so that the patient should be kept in bed for a few days.

Treatment.—The fragments should be manipulated into the best possible position, usually under anæsthesia, and a small, soft, wool pad should be plaeed in the axilla. The pad should be very loose,

and serves more to keep the skin surfaces apart than to control the fragments. If the fragments are impacted, no attempt should be made to disimpact them.

Recovery of function cannot be expected even in favourable cases for seven to eight weeks. If the X rays show marked displacement, the visiting surgeon will consider the advisability of removing the loose fragment. The arm should be slung and massage may be started at once, but passive movement should be deferred until at least a week has elapsed. It must be used with caution. As soon as it is started, say eight or ten days after the injury, the elbow should be supported by a sling; and at the end of three or four weeks the patient should be encouraged to use the arm gently until function returns.

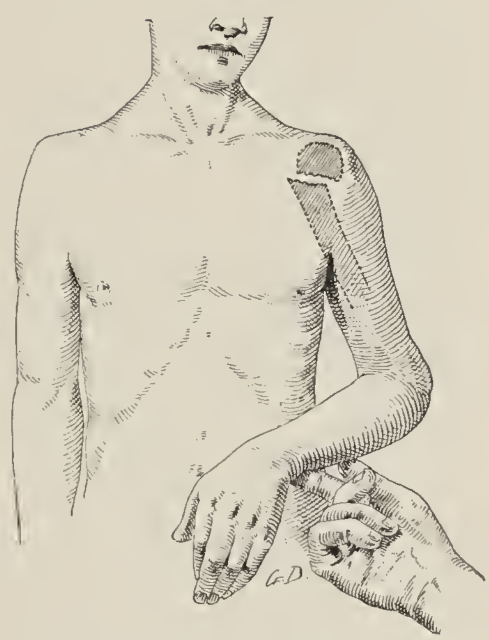


Fig. 99.—Fracture of the Surgical Neck of the Humerus.

2. *Fractures of the Surgical Neck* (*Fig.* 99) are of several kinds: (*a*) There is little displacement, and no difficulty is experienced in obtaining and maintaining a good position; (*b*) The lower fragment is displaced inwards and the upper is abducted, and the displacement is apt to recur; (*c*) Marked displacement is present—the upper fragment may be displaced outwards, the lower inwards, and dislocation of the head may accompany the fracture.

Treatment.—*a.* When manipulation and X rays show the fragments to be in good position, either with or without reduction, a snug, conical pad of wool running from the axilla to the elbow should be applied and the arm should be bandaged to the side. The elbow is bent to a right angle, and the whole extremity is slung to the neck by a clove-hitch passing round the wrist (*Fig.* 100). The elbow should not be supported, as the weight of the arm acts as an extension and prevents shortening.

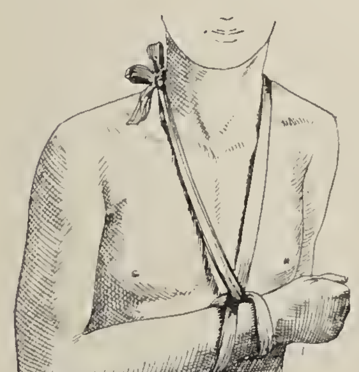


*Fig.*100.—Wrist slung from Neck by Clove-hitch.

Massage can be undertaken at once, the cap being readily removed. Passive movement should be started at the end of a week, the upper end of the humerus being grasped by one hand, so as to steady the fragments. The hand should grasp the shoulder from the back, so that the fingers lie in the axilla, pressing against the lower fragment, the thumb being placed on the great tuberosity. On the left side the right hand of the operator will steady the fracture, while the left will hold the elbow and perform the movement.

Retentive apparatus should be kept applied for four weeks, a sling

should be used for two weeks, and free use of the arm permitted at the end of six or seven weeks.

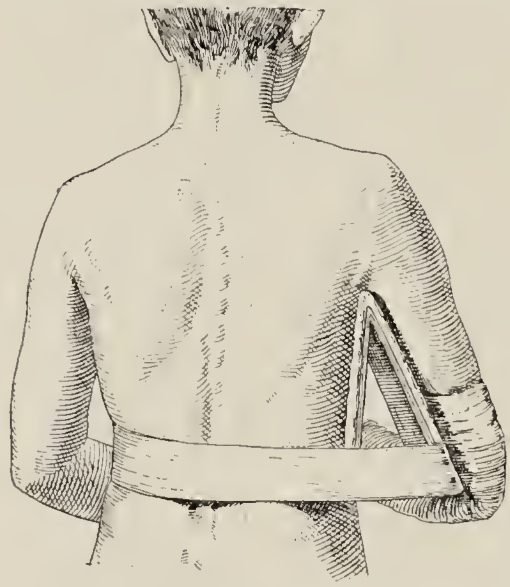


Fig. 101.—Showing Padded Wooden Triangle in Axilla.

b. In fractures of the second type we recommend the following treatment, which is also applicable to uncomplicated fractures of the shaft of the humerus. A long, well-padded tin splint is taken. This is bent into the form of a $\wedge$, the padding lying on the outer side. The apex of the $\wedge$ is packed into the axilla, and a soft bandage passing in a figure of **8** round the shoulder and opposite side of the neck slings it in position and prevents it slipping. The inner portion of the splint is bandaged or strapped to the chest, and the outer is secured to the arm by a bandage or a strap, and when this has been effected the arm is fixed to the side, and the forearm is slung to the neck, or, if preferred, is fixed with a bandage across the patient's chest. We have found this method simple and very satisfactory. The lower fragment is controlled with ease, and the whole arm can be readily uncovered for massage and inspection. The after-treatment is the same as for the preceding variety. Instead of a tin splint, a large pad, a modification of Stromeyer's cushion, is sometimes of service, or a padded wooden triangle secured round the waist (*Fig.* 101). Such a splint keeps the lower fragment abducted.

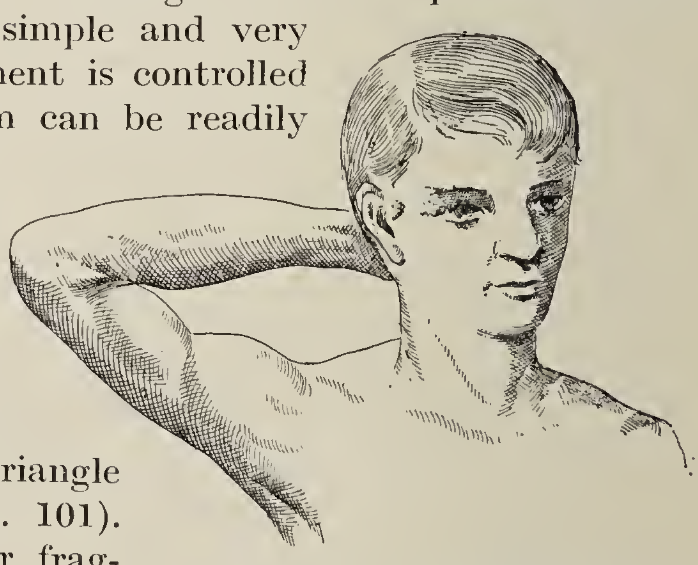


Fig. 102.—Arm-abducted Position for Fractures of the Great Tuberosity of the Humerus, or for Severe Fractures of the Surgical Neck.

c. The third variety of fracture is unsatisfactory. If there is no dislocation, but marked abduction of the upper fragment, it will be necessary to keep the arm abducted at right angles to the chest wall (*Figs.* 102, 103). In this position it is often possible to reduce the over-riding of the fragments; but if this cannot be effected, the normal alinement of the limb is preserved—a most important consideration. A modified Thomas splint with extension will allow the arm to be retained in this position, but in such circumstances the patient

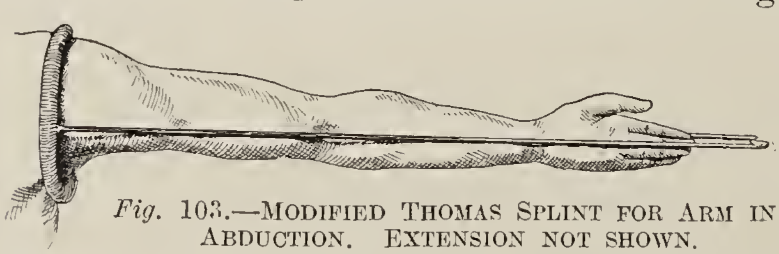


Fig. 103.—Modified Thomas Splint for Arm in Abduction. Extension not shown.

must remain in his bed until union occurs. As this confinement is very irksome, a plaster ease may be applied, the arm being abdueted, the forearm externally rotated, and the hand plaeed on the baek of the neek. If firmly fixed by plaster bandages in this position—extension being employed while the plaster is applied—a good result ean be attained. If manipulation fails to reduce the deformity, or if the deformity readily reeurs, an extension apparatus with weight and pulley should be employed (*Fig.* 104). As a rule it is advisable to attempt reduction by operation, espeeially if a dislocation is present, and for eonsideration of these details the reader is referred to the standard textbooks on surgery.

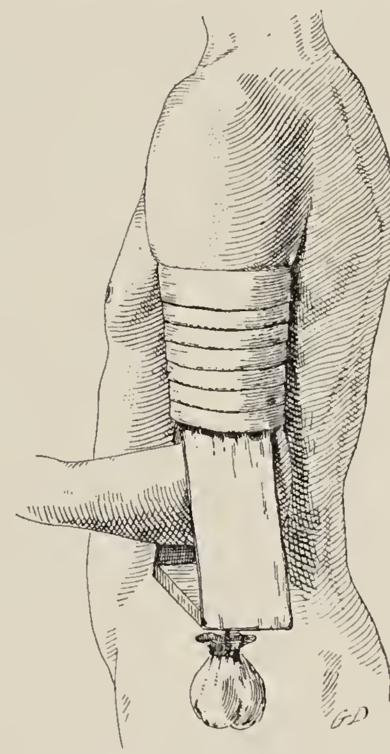
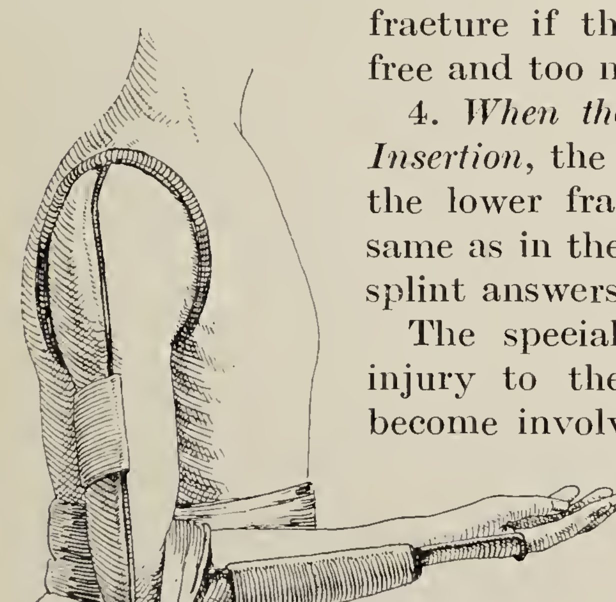


Fig. 104.—Fracture Treated by Extension Weight.

3. *Fractures of the Shaft of the Humerus.*—When the fraeture lies *above the Insertion of the Deltoid*, the upper fragment is usually drawn inwards and the lower outwards, but the displaeement is sometimes similar to that which occurs in fraeture of the surgieal neek, and the same forms of treatment reeommended in the first two varieties of this aecident will be found to answer admirably; indeed, they are to be advised. It is said that non-union is common as a result of this fraeture if the elbow has been allowed to hang free and too mueh movement has been permitted.

4. *When the Shaft is Broken below the Deltoid Insertion*, the upper fragment is drawn outwards, the lower fragment inwards. Treatment is the same as in the last injury—some form of Thomas splint answers well (*Fig.* 105).



Figs. 105.—Jones's Method of Using a Bent Thomas.

The speeial eomplieation of this fraeture is injury to the museulospiral nerve, whieh may become involved in the callus from the fracture. Signs of paralysis are to be looked for in the appearance of wrist-drop and radial anæsthesia. If wrist-drop alone is present, the nerve is probably only bruised and will reeover (*see* 'Sprains with Nerve Injury,' Chapter XIX); but if anæsthesia is marked, the prognosis is more serious. Unless improvement takes place, it may be advisable to cut down and free the nerve from the surrounding sheath of callus.

INJURIES IN THE NEIGHBOURHOOD OF THE ELBOW-JOINT.

Following falls or blows upon the elbow a number of different lesions may be met with. As in the case of the shoulder, a careful systematic examination must be made in order that an accurate diagnosis may be arrived at. Both arms should be exposed. First examine the bony points, the olecranon and the external and internal condyles. When the forearm is extended, these three points lie in the same line ; on flexion, however, a triangle is formed which has its apex formed by the olecranon, its base by a line joining the two condyles (*Fig.* 106). Owing to the natural oblique axis of the ulna, the olecranon lies nearer the internal than the external condyle, and the internal is the more prominent of the two.

If these points bear their normal relationship to one another, there is no dislocation of the ulna. Dislocation is a common accident, and must first be excluded.

The olecranon is superficial, and examination will always reveal the irregularity of a fracture. If there is separation of the condyles, a T-shaped fracture into the joint is present.

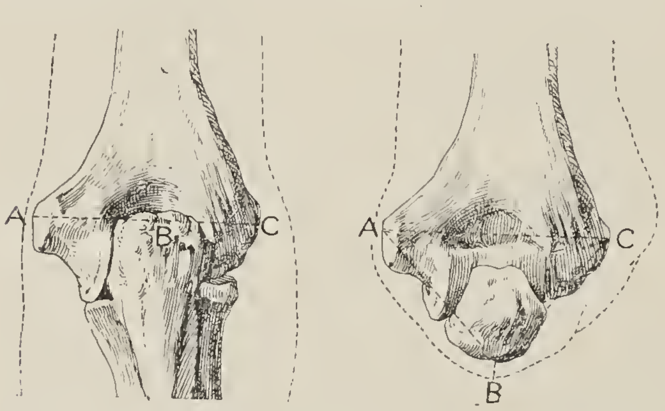


Fig. 106.—Position of Bony Points round Elbow in Extension and Flexion.
A. Internal Condyle. B. Olecranon. C. External Condyle.

Next grasp the condyles with one hand and the shaft of the humerus with the other. Preternatural mobility with crepitus suggests a fracture of the lower end of the shaft. With such a fracture the lower smaller fragment is usually displaced backwards, the olecranon becomes abnormally prominent, and the condition may easily be mistaken for a dislocation. This is a common error, but a careful examination of the bony points should settle the diagnosis.

If there appears to be no solution of continuity of the shaft of the bone, run the fingers down along the supracondyloid ridges to make sure that the condyles are intact. A fracture of the internal condyle is easily overlooked. Then examine the head of the radius. This lies close beneath the skin immediately below the external condyle. If in its normal situation, it can be felt to rotate when the movements of supination and pronation are performed. An assistant should perform these movements, in order that the mobility of the radius may be better appreciated. If this movement is absent, and crepitus attends the attempt to produce it, a fracture of the neck of the radius is present. If the head of the bone is abnormally prominent, there is a backward dislocation ; if there is a hollow in the place which should be occupied by the head of the bone, there is a forward dislocation.

In fractures of the humerus there is usually shortening when measurements are made from the acromion process to the external condyle.

Dislocations often accompany fractures near the elbow-joint. There is frequently so much swelling that an accurate examination cannot be made ; all cases, therefore, should be submitted to the X rays as soon as possible.

The Transverse Supracondyloid Fracture of the Humerus.—The line of fracture runs just above the condyles, and is sometimes oblique. The lower fragment is displaced backwards.

The displacement should be reduced under anæsthesia. The elbow is flexed, and extension is applied to the lower fragment by grasping the condyles or the forearm, counter-extension being maintained by an assistant, who holds and steadies the arm. Manipulation of the lower fragment, i.e., pressing it forwards while the shaft is pushed backwards, should be employed. As soon as this reduction has been effected, the elbow should be flexed as much as possible, and the bones secured in this position by a tin splint (*see Fig.* 64, p. 95) or a trough of poroplastic material.

It may be laid down as a general rule that for all fractures of the humerus in the neighbourhood of the elbow-joint, with the exception of fracture of the olecranon process, the acutely flexed position is the best, *the hand being supinated.*

There are, however, some cases in which the swelling after the injury is so great that the elbow cannot be flexed even to a right angle. In these circumstances the patient should be kept in bed, and evaporating lotions or an ice-bag applied to the arm, which should rest in a comfortable trough of poroplastic well padded with wool. As soon as the swelling subsides, which it will do in two or three days, efforts should be made to get the elbow into the required position of acute flexion. If it is impossible or inconvenient to obtain this position, the limb should be put up at right angles on an anterior or a posterior angular splint. In children, and even in adults, the use of a splint may be dispensed with, the elbow being maintained in a position of acute flexion by means of strapping and bandages, *the forearm being fully supinated.*

A very careful watch must be kept over the circulation in such cases, for one of the dangers of the position, admirable though it is for the future, is that considerable pressure may be exerted on the blood-vessels.

Warning.—*While the acutely flexed position is of great value in treating fractures in the neighhourhood of the elbow-joint, it must be used with care. Ischæmic paralysis has followed its use in many cases where there has been much swelling.*

If the fracture has been reduced satisfactorily, there will be no risk of the fragments moving, so that the splints can be removed at any time, and the elbow be thoroughly inspected and massaged.

At the end of a week passive movements should be commenced. The movements of gradual extension and flexion should be carefully undertaken, the region of the fracture being steadied with one hand to prevent any displacement taking place.

After a fortnight, the forearm should be slung by a clove-hitch to the neck, and day by day the amount of flexion should be diminished. By this means the elbow will be gradually brought down to a right angle, and each day the range of movement will increase.

After a month, any splint, if one is used, may be dispensed with, and the patient is encouraged to practise gentle active movements, the range of extension being cautiously increased occasionally under an anæsthetic. These manœuvres should not be violent, and if they result in pain and diminution of mobility they are clearly injuring the callus and they must be stopped. It is often necessary to break down a few adhesions under an anæsthetic to restore complete extension.

T-shaped fractures into the joint are treated on the same principles, but early massage and passive movements (third day) are necessary. Adhesions are liable to form, and these must be broken down under an anæsthetic.

Bad comminuted fractures are difficult to treat, as it is often impossible to manipulate the fragments into position. Such cases may require operative measures.

Fractures of the Condyles.—Fracture of the external condyle usually involves the elbow-joint, fracture of the internal condyle need not do so. Both fractures can be satisfactorily treated by acute flexion on the above lines ; or, if preferred, an internal angular splint may be fitted for fractures of the external, an external angular for fractures of the internal condyle. Union takes place by fibrous tissue, but the functional result is good. A pad should be applied over the fractured condyle to keep it in position. Passive movement is not required for at least ten days, and is then employed with the same precautions as in the case of the transverse fracture.

Fracture of the Olecranon Process.—This is a fairly common fracture, and one that is best treated in many cases by an operation. Much will depend upon the general condition and occupation of the patient, and the amount of separation of the fragments. If there is but slight separation, excellent results may be obtained by the use of splints.

The arm should be put up in a position of almost complete extension, and a splint—a padded tin splint is the best—should be applied along the flexor surface, reaching from the anterior axillary fold to the palm of the hand. A moulded poroplastic covering which fixes the arm in the above position gives excellent results. Full extension should not be employed, as it is very irksome to the patient, and tends to produce dislocation if there be wide separation of the fragments.

Besides the splint, strapping should be applied in a figure-of-8

manner around the point of the elbow to exert traction on the upper fragment, which is pulled up by the triceps. This position is maintained for a week, during which the arm should be gently massaged. At the end of this time the splint should be taken off and the elbow moved very gently. Only a small range of movement should be attempted, and the loose fragment should be steadied with one hand and pressed down towards the ulna.

At the end of the second week the position of the forearm should be changed, the degree of flexion should be slightly more acute, and by a gradual process the elbow should be brought to the position of a right angle at the end of the fourth week. Union, generally fibrous, will take place towards the end of the sixth week, after which the splints may be discarded. No severe exertion should be permitted for another month.

Fractures of the Coronoid Process usually complicate backward dislocations of the radius and ulna. The dislocation should be reduced and the forearm put up in a position of acute flexion, the after-treatment being the same as for fractures of the lower end of the humerus.

It is sometimes necessary to remove the loose fragment.

FRACTURES OF THE FOREARM.

The Bones of the Forearm.—If one bone be broken, treatment is very simple and satisfactory, since the sound bone acts as a splint. On the other hand, when both the bones are fractured, there may be considerable difficulty in obtaining accurate adjustment and firm union.

General Principles of Treatment.—If the radius is broken, either alone or together with the ulna, it is of the utmost importance to determine the position of the radial fracture with regard to the insertion of the pronator radii teres.

When the fracture lies above the level of this muscular insertion, the upper fragment is supinated by the biceps and supinator brevis and flexed by the biceps, the lower fragment being fully pronated. In order that the fragments may be got into good apposition, the arm must be put up in full supination (*Fig.* 107).

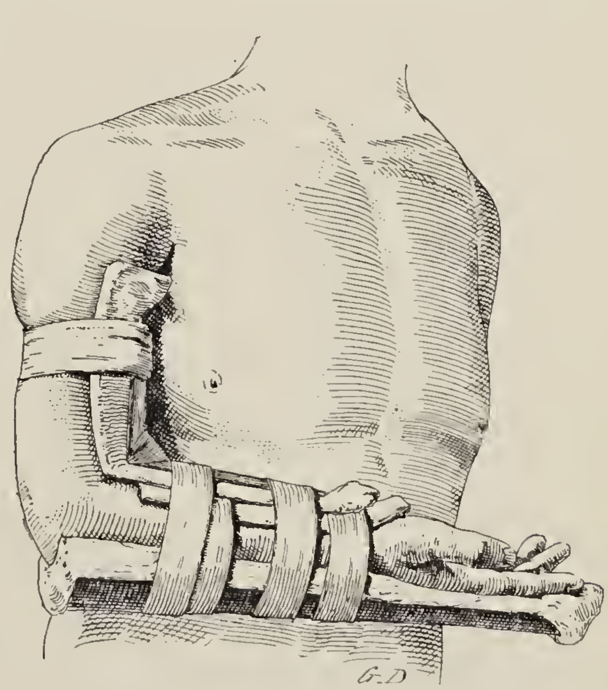


Fig. 107.—Splints for Fractures when above Insertion of the Radial Pronator.

When the fracture lies below the insertion of this muscle, a position midway between supination and pronation is the best, for the following reasons : (1) The actions of the pronator and supinator muscles are about equally balanced ; (2) It is a position

of comfort to the patient ; (3) The widest degree of separation between the bones is obtained in this position.

The greatest care must be taken to see that the ends of the fractured bones are not pressed in towards one another, for in this position vicious union will occur. Wide splints must therefore be selected which will not compress the bones laterally.

When both bones are broken, there is a tendency for the ulna to sag down and produce an angular deformity. This must be prevented by putting the limb up fully supinated.

The limb should be put up on a posterior or anterior angular splint, and a short splint should be applied along the front or back of the forearm according to the method selected. An excellent splint for the purpose has been made by Montague, New Bond Street ; it is a posterior angular splint of aluminium, interrupted at the elbow by a hinge fixed by a screw ; this enables the surgeon to fix the forearm in any position of flexion, and further, to move the elbow-joint without interfering with the fracture. An anterior splint is applied from the bend of the elbow to the centre of the palm.

When the fracture is below the insertion of the pronator radii teres, an internal angular splint, with a short external straight splint, may be employed if both bones are fractured. It is not always necessary to include the elbow-joint in the splinting, but it is safer to do so. When only one of the bones is broken, or if satisfactory control can be obtained, the forearm should be fixed by broad well-padded external and internal splints, reaching from the elbow to below the wrist-joint.

These fractures must be very carefully watched, and the splints should be removed at frequent intervals so that the position of the fragments can be ascertained, and the following precautions are to be observed: (1) The splints must not include the fingers: they should reach only to the middle of the palm; (2) They should not be applied too tightly, as there is a danger of ischæmic paralysis developing ; (3) Any tendency to angulation of the ulna must be treated at once ; if necessary, an anæsthetic is to be given and the bones are to be straightened.

Splints should be kept on for a month when a single bone is fractured, six weeks when both are damaged.

Massage should be started during the first week, passive movement of the elbow and wrist after eight to ten days. It must be remembered that it is most important to preserve the power of supination.

Colles's Fracture.—This common injury is a fracture of the lower end of the radius just above the wrist-joint. It results from falls on the outstretched hand, the violence being chiefly directed to the radial side of the palm. As a result, the radius breaks across through the cancellous tissue, and the lower fragment is displaced backwards. This backward displacement is accompanied by a rotation of the

fragment on two axes : (1) A rotation on a vertical axis so that the outer part of the fragment is more displaced than the inner, which still maintains its attachment to the ulna by means of the triangular fibro-cartilage ; (2) A rotation on a transverse axis, so that the articular surface for the bones of the first row of the carpus is directed towards the dorsum of the hand.

This triple displacement, as it is called, causes the hand and wrist to appear shaped like a fork, radial abduction being present, while the styloid process of the radius, which should lie half an inch below that of the ulna, is found on the same level, or even higher.

Treatment.—The deformity must be corrected, an anæsthetic being usually required. The patient's hand is grasped by the surgeon, who uses the right hand for a right-, the left hand for a left-sided fracture. Bearing in mind the direction of the displacement, extension is made, counter-extension being applied by an assistant, who grasps the elbow. The surgeon fixes the region of the fracture with his unoccupied hand, and by exerting pressure with his thumb, presses the displaced lower fragment into position ; the final movement being one which wrenches the hand into a position of ulnar adduction, so overcoming the radial displacement.

The hand is then placed upon a Carr's splint (*Fig.* 108), which maintains it in the adducted position. Carr's splint is very useful in the treatment of these cases, but certain modifications may be adopted with advantage : (1) The posterior splint is usually made too narrow : a broader one should be obtained ; (2) Hospital patients occasionally are extremely careless, and by injudicious movement may cause the recurrence of the displacement ; in order to prevent this, two small pads, placed one over the lower fragment and the other under the lower end of the upper fragment, will be found of service ; (3) If these splints are applied too tightly there will be a great deal of troublesome swelling of the fingers, especially in gouty people.

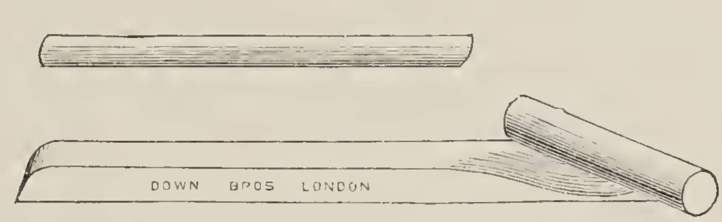


Fig. 108.—Carr's Radius Splint.

Severe types of Colles's fracture with much displacement, especially those in which the fracture is impacted, cannot be reduced and treated by the above method. In such cases Sir Robert Jones's plan (*Fig.* 109) should be employed. To quote his words : "To reduce a left Colles fracture, the surgeon takes the patient's forearm in his left hand, with his own scaphoid tubercle against the lower end of the shaft ; he then places his right hand on the dorsum of the patient's wrist, with his own scaphoid on the projecting lower fragment. A firm grip, with a slight traction and twist of the wrist, completely reduces the deformity. The anterior aspect of the radius has a distinct concavity at its lower end. . . . If this curve is reproduced, reduction is

complete." A pad of wool is placed over the lower end of the upper fragment in front, and over the small lower fragment posteriorly, and these in turn are secured by splints of thin metal with a slight spiral twist. "The *posterior splint* extends from the external condyle of the humerus to about the middle of the metacarpals, and runs spirally from the ulnar side at the elbow to the radial side below. The *anterior splint* on the palmar aspect of the forearm has the twist in the opposite direction, and must stop short of the thenar eminence" (*Fig.* 110). The splints are secured by strapping, and the forearm is slung. A Colles's fracture properly reduced never gives trouble. No movement which can strain the newly-formed callus should be allowed for three or four weeks. Injudicious passive movement and vigorous massage are harmful. If the callus is strained, the whole wrist becomes stiff and painful. The splints are kept on for three weeks (being taken down for inspection when necessary), light use of the fingers being permitted and encouraged. The posterior splint is then removed, the anterior being retained, and active movements of the wrist are practised, but no severe strain is to be put on it. Massage may be used, but it is most effectual after the fracture has united. (Jones on *Injuries to Joints.*)

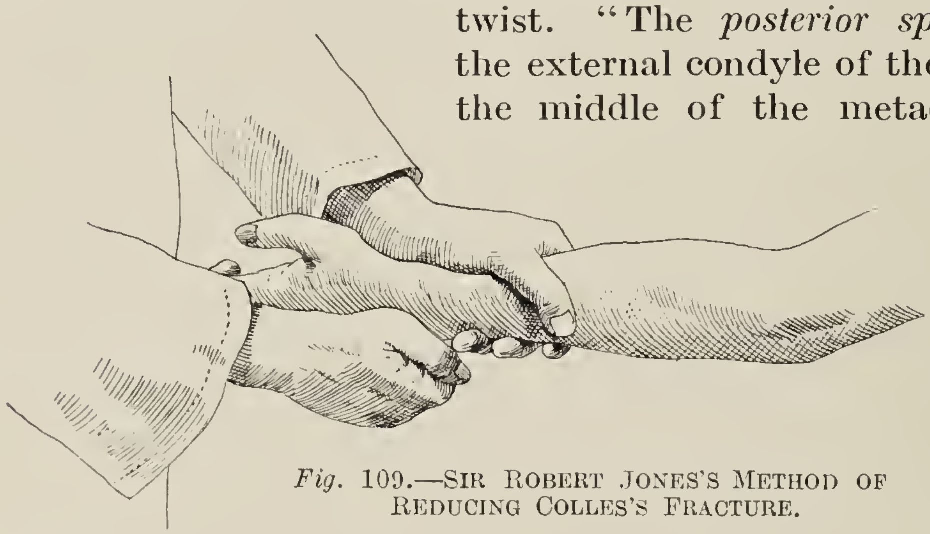


Fig. 109.—Sir Robert Jones's Method of Reducing Colles's Fracture.

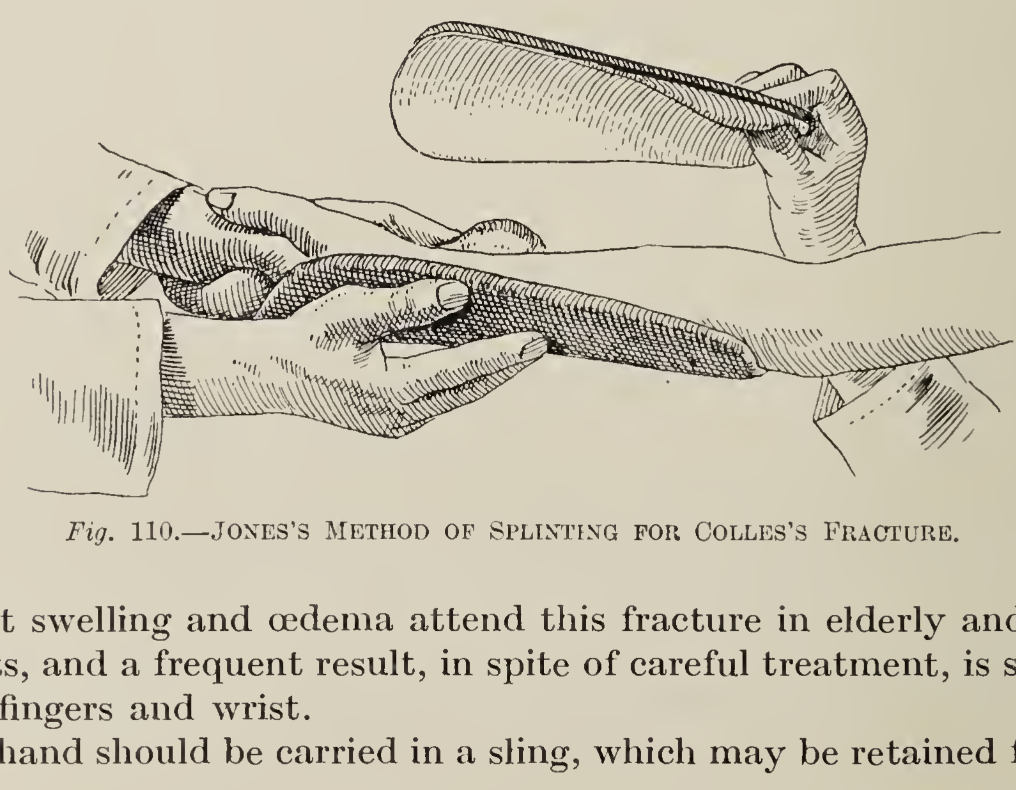


Fig. 110.—Jones's Method of Splinting for Colles's Fracture.

Great swelling and œdema attend this fracture in elderly and gouty subjects, and a frequent result, in spite of careful treatment, is stiffness of the fingers and wrist.

The hand should be carried in a sling, which may be retained for four

or five weeks. The splints should be left off at the end of three or four weeks.

Fractures of the Carpal Bones.—These are common as the result of falls or strains, and a 'sprained' wrist is often associated with a fracture of the scaphoid or other carpal bone. X rays show how frequently this accident complicates a chronic sprain, and there is little doubt that the condition is aggravated by the popular methods of treatment by early passive movement.

All injuries of the wrist should be treated with the wrist in dorsiflexion, and if a fracture be present, it should be given rest and allowed to consolidate before passive movements are started.

Fractures of the Metacarpal Bones.—The principles of treatment are very simple. In all cases of blows on, or injuries of, the hand, an X-ray photograph should be taken. If much displacement is present, attempts must be made to rectify it under anæsthesia, and a splint should be applied until the danger of recurrence of the deformity is passed, usually about ten days.

For the metacarpal bone of the thumb, a small strip of zinc is padded and moulded to the thumb, which is abducted; the splint is fixed by strapping at the wrist and at the interphalangeal joint.

For the other metacarpal bones, a palmar splint as for the carpus is employed, with a round padded end to fit into the palmar arch. It is often quite sufficient to bandage the hand over a golf ball covered with a pad of cotton-wool.

In some cases, where there is marked displacement of a fragment of bone, it is necessary to cut down and remove it.

THE PELVIS.

Fractures of the pelvis result from such injuries as crushes, blows upon the trunk, and buffer accidents. Almost any part of the pelvis may be damaged. In the more severe cases the fractures are often bilateral, and sometimes the head of the femur is driven through the acetabulum into the pelvic cavity. The diagnosis is made, first, by the history of the injury ; secondly, by the detection of crepitus when the bones are carefully palpated, by pain localized in one particular spot when the bones are compressed, by pain induced by coughing, and in most instances by an inability of the patient to flex the thigh on to the abdomen. These fractures are not in themselves serious, and they unite quite readily, but the complications which accompany them may be fatal. These complications are rupture of the urethra, rupture of the bladder, injuries to the rectum, and laceration of the nerves and blood-vessels.

A case of fractured pelvis, or one in which a fracture is suspected, must be treated with the greatest possible care until the above complications have been excluded. The routine treatment of such a case is as follows :—

The patient is stripped, and is carefully examined, attention being paid to the special points referred to above. The urethra is examined for signs of bruising or for evidence of recent hæmorrhage. The patient is asked whether he has passed his water since the accident; if so, whether any special difficulty accompanied the act. If a negative reply is received, the first step is to ascertain whether the urethra and bladder are intact. This is done in the following way:—

The Urethra.—As a rule in injuries of the urethra the canal is torn or damaged by separation of the bones of the pubic arch, the triangular ligament which supports the urethra at this situation being stretched and torn. Occasionally the injury results from spicules of bone which are driven directly into the wall of the urethra. In most instances there are obvious signs of such damage, in the form either of blood escaping from the meatus or of a perineal swelling. *Under no circumstances should a patient in whom an injury of the urethra is suspected be allowed to pass his urine naturally.* Attempts must be made at once to locate the situation of the injury and to estimate its gravity by the passing of a catheter. For this purpose a gum-elastic instrument should be employed first, and if this fails it is necessary to make an attempt with a silver instrument pending further operative procedures. Should the catheter enter the bladder without much difficulty, it is probable there is only a bruising or slight laceration of the urethral wall; in which case it will not be necessary to do more than pass the catheter at regular intervals, say every four hours, a careful watch being kept on the perineum for signs of extravasation. This is a most important observation, because, although there may be a comparatively free passage to the catheter, a small amount of urine may leak through a bruised urethra into the perineal pouch, and set up extensive suppuration. Supposing, however, that the catheter is introduced with difficulty, accompanied perhaps by fresh hæmorrhage, then it would be wiser to tie in the catheter, and, as before, while the bladder is draining, the perineum must be carefully inspected, and any signs of extravasation treated immediately. If the catheter cannot be passed, no time must be lost in sending for the visiting surgeon and in preparing for perineal section. It cannot be too clearly laid down that the majority of gross injuries to the urethra are best treated by operation.

Injuries to the Bladder.—The question of urethral injuries having been settled, the next duty of the house surgeon is to ascertain whether there is any evidence of injury to the bladder. Such injuries may occur either on the peritoneal or non-peritoneal surface of the organ. In the former case the urine escapes into the peritoneal cavity, and if the condition is not promptly relieved, septic peritonitis will be the result. In the latter class the rent is on the anterior surface of the viscus, and the urine escapes into the space of Retzius, from which it will mount up behind the muscles of the

abdominal wall. Many cases of bladder injury are readily diagnosed, but there are some in which the detection of this visceral damage is exceedingly difficult. The special points on which stress is to be laid are the following: First, the patient usually expresses an intense desire to pass water, but is completely unable to perform the act. This is one of the most important diagnostic symptoms, and it arises only after injuries, either from rupture of the organ or from retention of clot within the cavity. Should this symptom be present, the next step is to pass a catheter into the bladder. In most cases, if the bladder is injured, nothing but a little blood-stained urine will be withdrawn. This in itself is sufficiently suggestive, but the diagnosis must be further confirmed by the following procedure. A measured quantity of boracic-acid solution—6 to 8 oz. in a child, and 12 to 16 oz. in the adult—should be slowly injected, remain *in situ* for half a minute, and then be allowed to return into some receptacle. This manœuvre should be repeated three times, after which any gross discrepancy between the amount injected and the amount returned will give definite evidence of a rent in the bladder. Certain precautions should be observed in making this test, and certain fallacies avoided. If the rupture is intraperitoneal, the injection of the fluid may give rise to a considerable amount of shock. If this be so, the experiment must not be repeated; there will be sufficient evidence at hand to warrant an exploratory operation, and the surgeon should be notified. When the rupture is extraperitoneal, the fluid often collects in the areolar tissue behind the pubes, and a species of false bladder is formed, into which fluid may be injected, and from which it may be withdrawn without any noticeable diminution in quantity. Under such circumstances, however, it will be noticed that the abdominal muscles become increasingly rigid with the injection of the fluid, and a considerable amount of pain will be caused, added to which an irregular dullness will be found on percussing above the pubes. Such dullness will not conform to the outline of the bladder, nor will there be the feeling of a distended organ conveyed to the hand. Sometimes, too, the opening in the bladder is small and becomes plugged with swollen mucous membrane or the perivesical fat. In such cases, unless care is taken to actually *distend* the organ, there may be no discrepancy noticed when the fluid is returned, and the rupture may be overlooked. In any case where such symptoms are present, the presumption is that the bladder is injured, and steps must be immediately taken to deal with the damage.

Injuries to the Rectum.—These are fortunately rare, and are most usually caused by a fracture of the coccyx, which is displaced forwards against the rectal wall. In most cases nothing more than a slight laceration exists, which can be dealt with by rectifying the position of the displaced bone, but in more severe injuries extensive operations may be required later on.

Injuries to the Blood-Vessels and Nerves.—Apart from serious

immediate hæmorrhage which would attract attention by the usual signs of such an accident, injuries to blood-vessels cannot be considered as requiring immediate treatment, but thrombosis of the pelvic veins may be a complication leading later to a fatal issue. Injuries to the nerves will be best considered under the head of 'Injuries of the Spine.'

Any of the above complications having been satisfactorily remedied or excluded, the fractured pelvis is treated by surrounding the pelvis with a firm wide binder. The patient should be placed upon a fracture-bed, which is better at first than a water-bed, owing to the immobility of the latter. Attempts may be made to manipulate the fragments into the best possible position, although in most instances such treatment is unavailing, and fortunately no bad results occur from their malposition. The knees should be fastened together. Special care must be taken to prevent bed-sores developing ; if the skin becomes red and tender, an air-bed or a water-bed must be substituted for the fracture-bed. The patient should be confined to bed for six to eight weeks at least, at the end of which time, if union appears firm and if no complications have developed, he may be got up into a wheel-chair, the pelvis being supported with a poroplastic or leather splint. He must not, however, be allowed to walk for three months from the time of the injury.

Fractures of the pelvis are often associated with thoracic and abdominal injuries, and the house surgeon must be very careful not to overlook these, which may be more serious than the actual fracture. The great shock which attends this accident must also be treated.

THE FEMUR.

As a result of direct or indirect violence, a number of different injuries may be sustained in the region of the upper end of the femur, of which the following are examples : (1) Intracapsular fracture of the femoral neck : (2) Extracapsular fracture of the femoral neck ; (3) Separation of the upper femoral epiphysis ; (4) Dislocation of the head of the femur, with or without fracture of the acetabular rim. A routine examination of this region is therefore necessary in order to ascertain the exact nature of the damage. Note : (1) The presence or absence of shortening of the limb ; (2) The presence or absence of abnormal or normal bony prominences ; (3) The position of the limb—whether everted, abducted, or flexed. Measurements should be taken from the anterior superior spine to the internal malleolus (*see Fig.* 84, p. 124), for in most of the injuries in this region a certain amount of shortening can be detected. The shortening is least in an intracapsular fracture, in which it rarely amounts to more than ½ in. In the extracapsular variety it may be as much as 1½ in., while in dislocation it may even exceed 3 in. Next, Bryant's triangle and Nélaton's line are to be defined, and the position of the trochanter

with regard to them is to be examined. The trochanter rises above Nélaton's line to an extent corresponding to the shortening of the limb in the three conditions previously mentioned, the displacement upward being most marked in the dorsal dislocation.

Nélaton's Line is an oblique line drawn from the anterior superior iliac spine to the tuberosity of the ischium. The line crosses the middle of the acetabulum and the top of the great trochanter when this bony prominence occupies its normal position (*Fig.* 111).

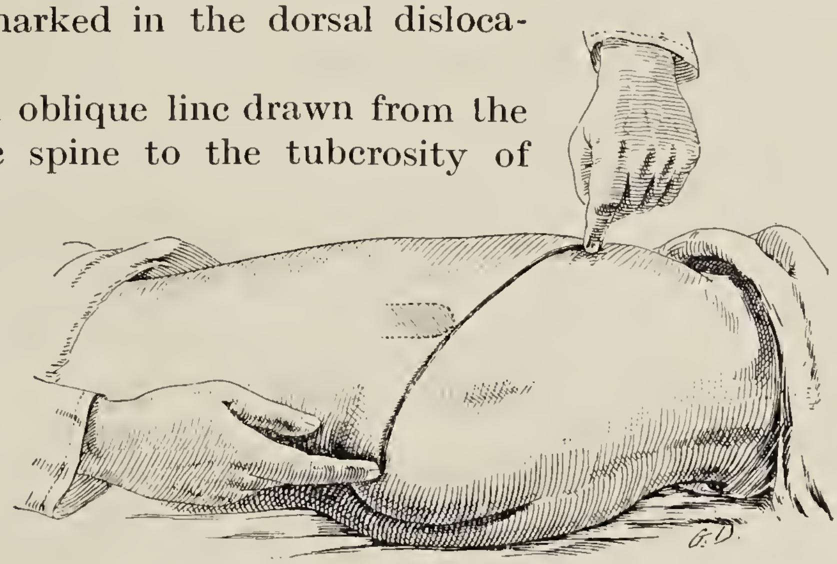


Fig. 111.—Method of Defining Nélaton's Line.

Bryant's Triangle is obtained in the following manner: With the patient lying supine, and both sides of the body being as far as possible symmetrical, a perpendicular line is allowed to fall from the anterior superior spine of the ilium. Another line is drawn upwards to meet this from the top of the great trochanter, and finally an oblique line joins the anterior superior spine to the trochanter (*Fig.* 113). If the position of the trochanter has been altered as the result of injury, the measurements obtained on the two sides of the body will not correspond, since, if the trochanter has been drawn upwards, the interval between the trochanter and the perpendicular line will be diminished; if it has been displaced backwards, the interval between it and the anterior superior spine will be increased. The advantage of this method is that it is not necessary to roll the patient over, as in defining Nélaton's line.

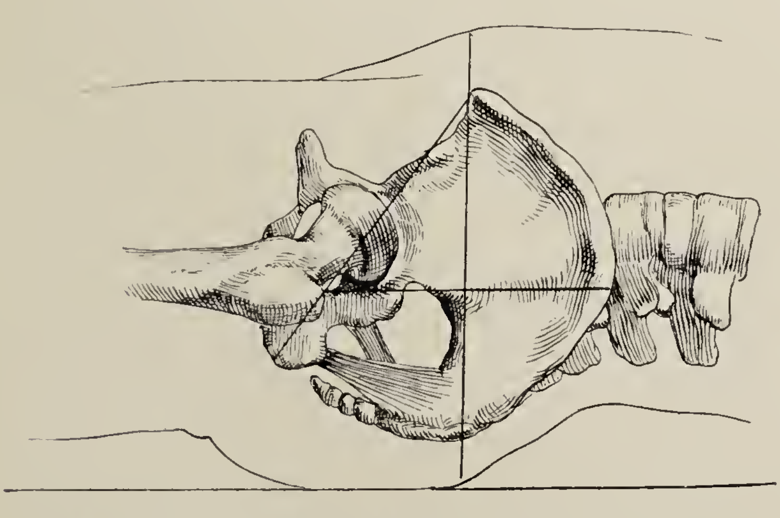


Fig. 112.—Diagram showing Bryant's Triangle.

Next, the limb is to be palpated, and then rotated. In an intracapsular fracture, the trochanter will be found to rotate through an arc of a circle slightly smaller than the normal. In the case of an extracapsular fracture, on the other hand, the arc of rotation is markedly diminished unless the fracture is impacted; while, in dislocation, rotation would be almost impossible owing to the preternatural immobility. The palpation may enable the examiner to detect

the presence of crepitus in the case of a fracture, but such a sign is not to be sought for, the other evidence being sufficient to establish the diagnosis. Next, if a dislocation is suspected, the hand or the fingers of the examining hand must be thrust into Scarpa's triangle, when, if a dorsal dislocation—the common form—is present, a loss of resistance will be noticed in this region as compared with the opposite side. On turning the patient over, the trochanter will appear more prominent in all these injuries, but its greater prominence in the case of dislocation and the marked widening of the gluteal region are very characteristic. The head of the bone in dislocation may be felt on the dorsum ilii, but it is not a sign to be absolutely relied upon, since in the sciatic variety the head lies so deeply that it may not be recognized.

The preliminary inspection and examination being over, the special signs denoting the particular kind of injury which has to be treated will now be dealt with.

Intracapsular Fracture.—This is a form of injury which occurs in elderly people, is produced by relatively slight violence, and is not accompanied by the signs of gross damage, such as bruising or swelling. The neck of the bone, having atrophied and softened with advancing age, snaps readily as the result of a slight fall or blow. The signs and symptoms are as follows :—

The patient lies with the leg motionless and everted. He is usually unable to move it himself. Inspection over the region of the hip shows perhaps some slight amount of swelling, and careful measurement will prove the presence of about $\frac{1}{2}$ in. of shortening. No attempt should be made to obtain crepitus, since this is likely to damage any bands of the capsule which still remain intact.

Treatment.—This accident, occurring as it does in the later periods of life, is usually treated without the definite object of obtaining firm bony union. In those cases where the fracture is impacted, no attempt should be made to alter the condition of affairs. The patient should be propped up in bed with the limb placed between sand-bags, and a careful watch should be kept for signs of congestion of the lungs, since this complication is more serious to the patient than the fracture itself. As soon as the tenderness and swelling permit, gentle massage of the part must be undertaken. At the end of about a month the patient should be allowed to get up, the fractured limb being supported by a pelvic splint (*see Fig.* 72), or a caliper splint (*see Fig.* 123). As soon as this period is reached—and the duration of bed treatment must be shorter when there is any risk of pneumonia—the patient should be allowed to get about on crutches, and encouraged to use the limb as much as possible. Since union is not aimed at, a species of false joint forms, which allows of a certain amount of activity, and the results are in the main satisfactory. Should such an accident occur in a healthy subject, whether old or young, as it sometimes does, in whom it is advisable to

attempt to obtain bony union, the patient should be treated in an abduction frame or by means of a Thomas knee-splint, the limb being abducted (*see below*). A Hodgen splint may be used as an alternative.

Extracapsular Fracture.—This accident occurs at all ages, but is most usual in young robust patients, when a considerable amount of direct violence has been applied to the region of the great trochanter. This process of bone is driven inwards against the neck, which splits the trochanteric portion of the bone into two parts, the neck itself becoming wedged between the fragments. The signs and symptoms are as follows: The limb is usually in a position of eversion—but if an impacted fracture is sustained when the limb is inverted, the inversion will persist. There are extensive bruising and swelling round the region of the hip-joint, and it may be very difficult to locate the position of the bony processes. If this can be done, it will be found that the trochanter is broadened and is raised an inch to an inch and a half above Nélaton's line; crepitus may be obtained by the ordinary examination. If the fracture is impacted, nothing but swelling, shortening of the limb (elevation of trochanter), and eversion may be found.

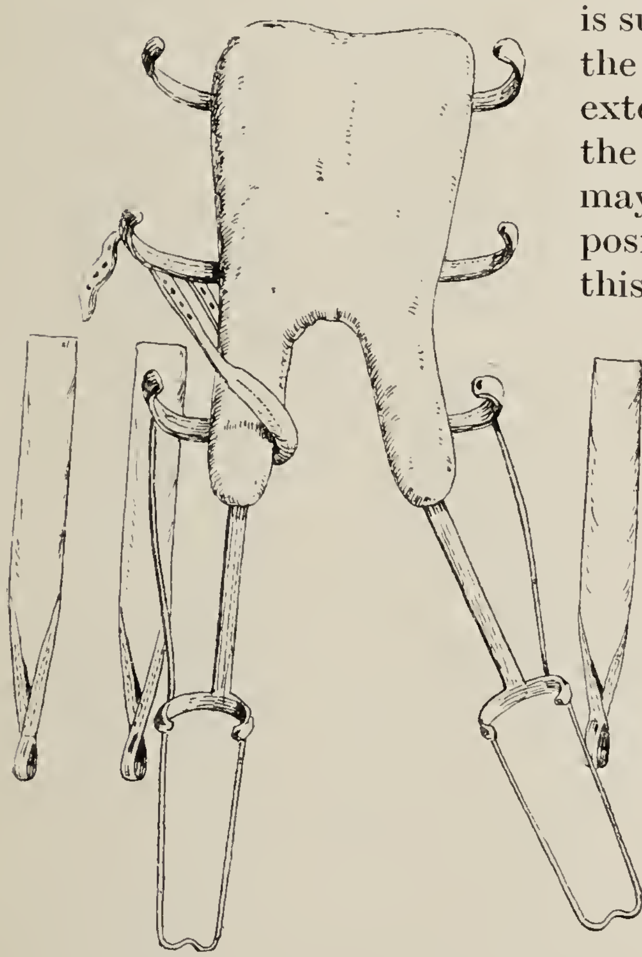


Fig. 113.—Thomas's Abduction Frame.

Treatment.—In uncomplicated cases, that is to say where impaction is not present, attempts may be made not only to bring the fractured surfaces into accurate apposition with one another, but also to obtain firm bony union. These results would be obtained by putting the patient under an anæsthetic, and applying forcible extension of the limb while the pelvis is steadied, so as to drag down the trochanter to its proper level. The extension apparatus is then to be fitted (*see* p. 167), and an abduction splint is applied, either in the form of the abduction frame (*Fig.* 113) or by means of a Thomas knee-splint (*Figs.* 114–117, 122, and *see* p. 169). The great mistake which has been made in the treatment of these cases has been in keeping them in the adducted position, with the result that the movements at the hip-joint are severely limited. It may be laid down

as a general rule that all fractures of the femur are best treated on an abduction frame or a Thomas knee-splint.

The abduction frame is awkward for adults, and as an alternative a Thomas knee-splint can be fixed on the affected limb, the limb being well abducted; but in this case *the opposite limb must be fixed by a Liston's splint*, otherwise the advantage of the abduction is lost.

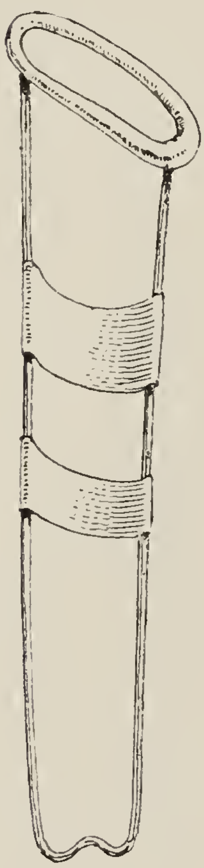


Fig. 114.

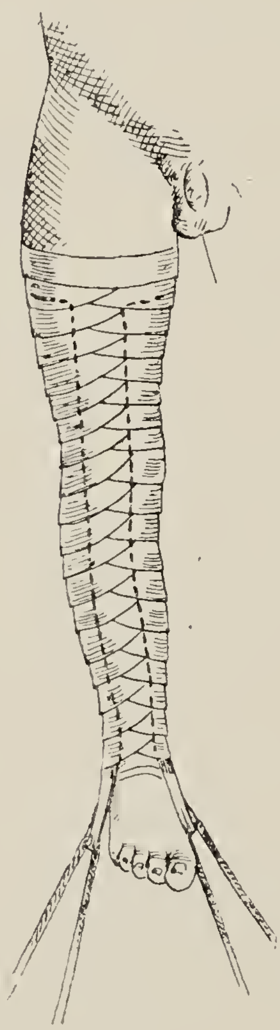


Fig. 115.

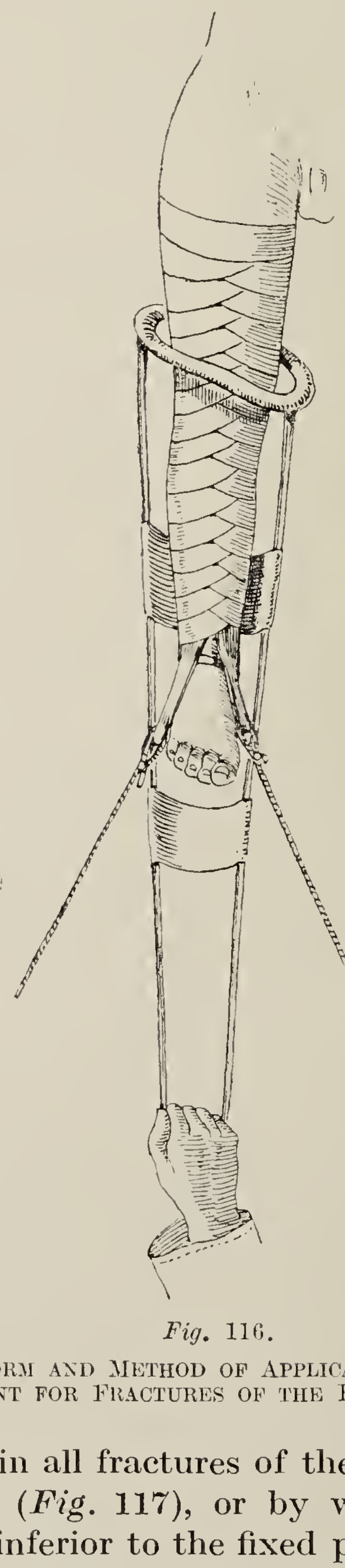


Fig. 116.

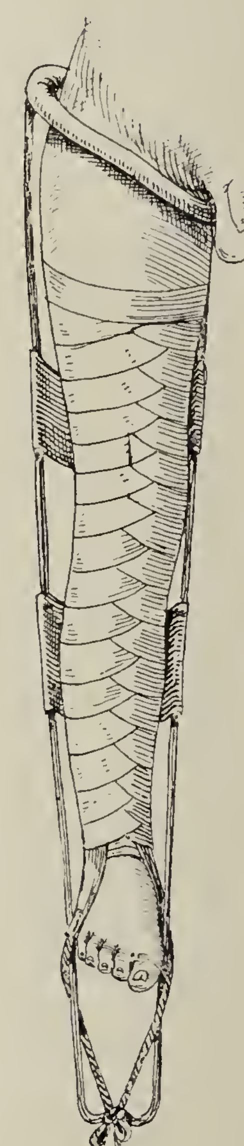


Fig. 117

Figs. 114–117.—Showing the Form and Method of Application of the Thomas Knee or Bed Splint for Fractures of the Femur.

Extension is to be applied in all fractures of the femur, either by a fixed extension to the splint (*Fig.* 117), or by weight and pulley—though probably the latter is inferior to the fixed pull. If weights are used, 10 to 20 lb. is necessary in order to tire out the muscles, which

would otherwise drag the femur in an upward direction. Special care must be taken to see that the foot is not too much inverted or everted.

If preferred, a Hodgen splint may be applied, care being taken to see that sufficient extension is exerted in order to keep the trochanter in its proper position. This treatment must be maintained for eight weeks, during which period the limb must be massaged regularly three times a week, the knee moved, and after a fortnight the hip-joint also. At the end of eight weeks the patient may be permitted to get up on crutches, and during this time every effort must be made to improve the movements of the hip-joint, which will probably be exceedingly stiff. One of the common results of the accident is ankylosis of the hip-joint. At the end of ten weeks he will begin to walk, and at the end of twelve he may be discharged.

In the case of the impacted variety, which is diagnosed by the history of the injury, the broadening of the great trochanter, and the swelling and bruising of the tissues over it, together with a definite amount of shortening of the limb, treatment must depend upon the age and condition of the patient and the degree of deformity produced by the impaction. In most cases where the patient is young and robust, it will be good practice to attempt a disimpaction of the fragments, or at least, to abduct the limb, and subsequent treatment similar to the above should be adopted. But when a patient is somewhat elderly and the deformity slight, even though there should be an inch of shortening, it is better not to attempt to disimpact, but to apply an extension in the abducted position.

Separated epiphyses will be considered under another head.

Fractures of the Lip of the Acetabulum.—The signs of this injury are those of the dorsal dislocation of the hip, and the true condition is recognized only when an attempt is made to reduce the deformity. Reduction is effected with comparative ease, but the deformity returns as soon as the extension is removed. Such cases are to be treated as fractures of the neck of the femur, after the head of the bone has been manipulated into its proper position.

Fractures of the Shaft.—The three common situations of the fractures of the shaft are : (1) Just below the lesser trochanter—the fracture being oblique ; (2) In the middle of the shaft—the fracture being transverse ; (3) At the lower end—the injury being often complicated by damage to the knee-joint. The chief difficulty in dealing with fractures of the shaft of the femur occurs in the first variety, owing to the obliquity of the fragments. In this injury the upper fragment is tilted forwards and outwards by the psoas and the gluteal muscles, and often forms a sharp angle immediately beneath the skin, the lower fragment being drawn up behind it. No apparatus will enable us to control the upper fragment, and in cases where displacement is marked, the fracture must be treated on a Thomas or Hodgen splint, the principle of the

treatment being to bring the lower fragment into accurate apposition with the uncontrollable upper fragment. Thosc cases of fractured femur in which displacement is not marked—and this especially

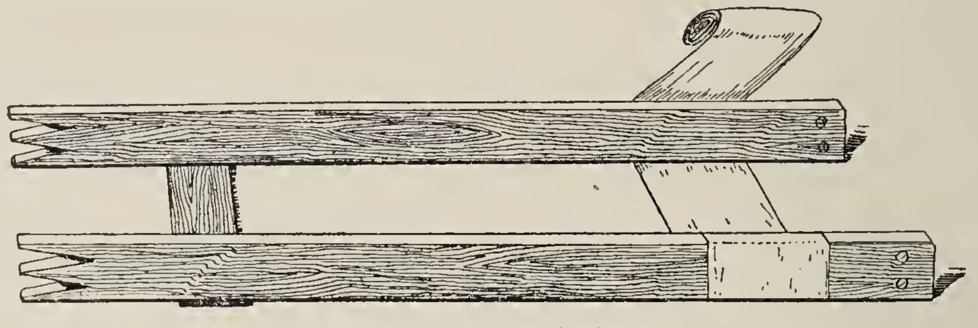


Fig. 118.—Hamilton's Splint.

applies to fracture of the middle of the shaft—may be treated by applying a Liston splint, short splints or Gooch's splinting being placed round the limb at the seat of the fracture, though the Thomas splint is much more useful, and is applicable to compound as well as

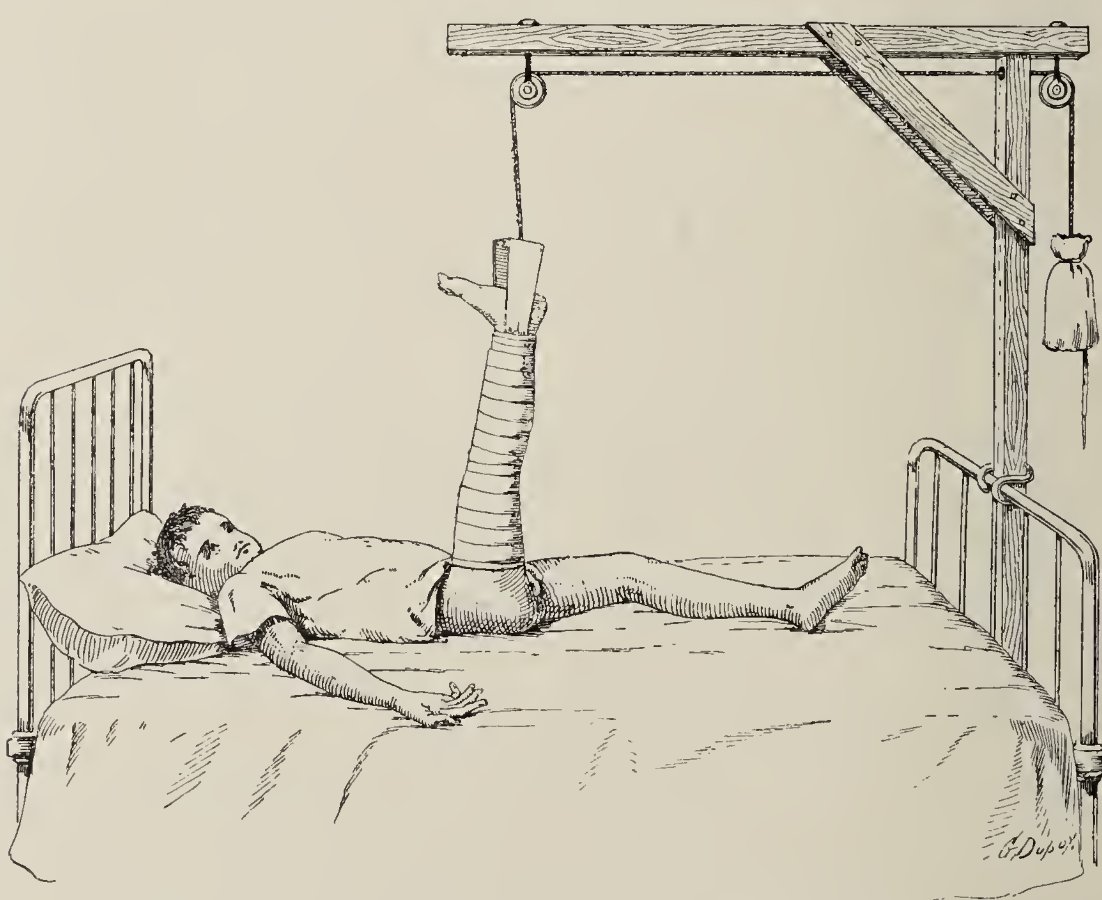


Fig. 119.—Gallows Splint, showing Method of Extension.

to simple cases. In very young children a double Liston splint, fixed by a cross-bar between their lower extremities, and known as Hamilton's splint (***Fig.*** **118**), is a most excellent apparatus, as it enables the child to be lifted from the bed, cleaned, and dressed without any trouble. Or, again, the gallows splint (***Figs.*** **119, 120**) may be employed, or some modification of it, by which the limb is slung at right angles to the trunk, and in this way any deformity arising

from the obliquity of the fracture can be overcome. Whatever method is employed, extension is to be applied. The procedure is as follows :—

The limb is carefully washed, and, if hairy, shaved. Two long strips of strapping, 3 in. wide, fixed below to a square piece of board $\frac{1}{4}$ to $\frac{1}{2}$ in. thick (slightly wider than the ankle opposite the two malleoli) which is known as the stirrup, are heated and pressed against the lower third of the fractured limb. They are here secured by short, thin pieces of strapping 1 to $1\frac{1}{2}$ in. in width, passed in a figure of 8 around the limb above the malleoli and ending just below the fracture ; the knee may be left uncovered. It is necessary to see that the pull of the extension is exerted on the femur and not on the knee, and this rule applies to extension in both fractures and diseases of the hip-joint. Large pads of wool should be introduced between the malleoli and the sides of the strapping, to prevent the skin over these processes becoming chafed. A cord is fixed to the stirrup and passes over a pulley at the end of the bed, and is there secured to a tin can which is filled with shot up to the required weight. If now the foot of the bed is raised on blocks, extension and counter-extension are obtained, the patient's body acting as a counter-extending weight. When the fracture has been manipulated into a good position under an anæsthetic (it is always necessary to control the fracture with some splints before the anæsthetic is given), the extension apparatus is applied, and Liston's splint is bandaged to the limb. A proper splint of this kind should extend from the axilla to below the foot, and it is secured to the patient in three places : (1) round the thorax, (2) round the limb at the seat of fracture, and (3) to the leg and ankle. In securing to the thorax it is necessary to take the first turn of the bandage round the splint from within outwards, and then round the back of the patient's thorax, the direction of the bandage in this way preventing the natural tendency of the splint to rotate forwards. Several turns should be taken round the thorax in order to retain it in position. The remaining bandages should be secured from without inwards, in order to check the tendency of the foot and leg to roll outwards.

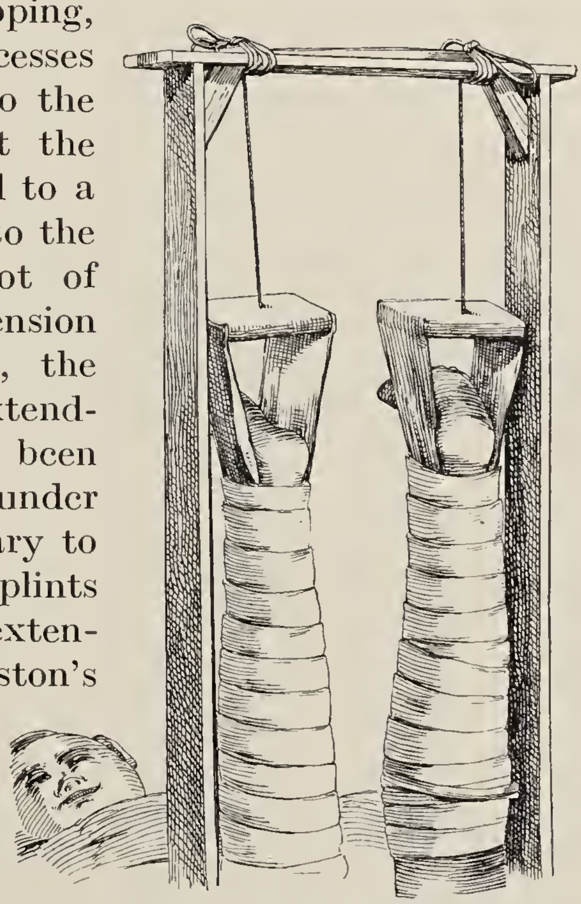


Fig. 120.—Gallows Splint for Fractured Femur in Child.

In order to prevent the rotation of the limb, a method advised by Cheyne and Burghard may be adopted (*Fig.* 121). This consists in

securing the limb at the level of the popliteal space to a short splint, 8 by 4 in., by means of a plaster-of-Paris bandage. The presence of this splint effectually prevents any rotation, either inwards or outwards.

Special care must be taken to see that the malleoli and the skin over the heel are not subjected to any great pressure. If the fracture is put up in this way it must be kept up for six to eight weeks, and the amount of weight applied to the limb must be varied according to the age of the patient and the tendency to deformity. Roughly, half a pound a year will be found to answer most purposes, but if there is much spasm the amount can be increased up to 20 lb. for an adult. At the end of six weeks, during which period the limb should have been regularly massaged—this can usually be done without disturbing the extension—the patient should be got up, and some form of retentive apparatus applied.

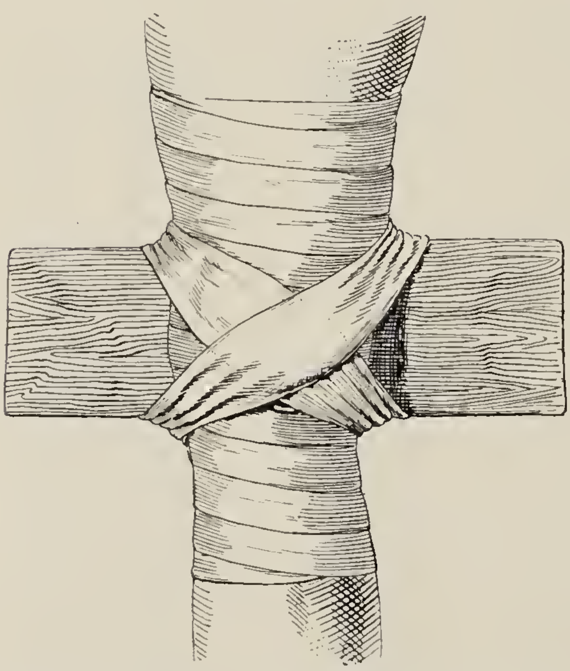


Fig. 121.—Cheyne and Burghard's Method for preventing Rotation of Limb.

In the case of children, a well-fitted poroplastic splint is all that is required, or, if preferred, a plaster case may be made.

Lower End of the Femur.—These fractures usually run through the condyles in the manner of the T-shaped fracture which is met with in the elbow, the result being : (1) the knee-joint is filled with blood, and adhesions are likely to form ; (2) the condyles are separated from one another, so that the relation of their articular surfaces to the articular surfaces of the tibia is altered.

Treatment.—If the fracture is a transverse one just above the condyles, an attempt should be made under deep anæsthesia to manipulate the fragments into accurate apposition. This is best done with the knee flexed, and owing to the tendency of the gastrocnemius to pull the lower fragment backwards, it may be necessary to divide the tendo Achillis or to put the limb up flexed nearly at a right angle in order to obtain satisfactory union. In all cases an X-ray photograph should be taken in order to ascertain the approximate position of the fragments. Fractures which involve the condyles must be treated on the same principles. Extension may be applied, but the chief object which the surgeon has in mind is to promote absorption of blood and to prevent organization of adhesions by early massage. In some cases it may be advisable to perform an open operation, but that will not be considered here. The duration of the treatment should be the same as for fractures of the shaft.

THE THOMAS SPLINT.

By D. McCrae Aitken, F.R.C.S.

Thomas's Knee-splint in Relation to the Treatment of Fractures. —In recent years the Thomas knee-splint or some modification of it has been extensively used for the treatment of fractures of the femur. Surgeons have, however, so modified its method of use to suit their own purposes and practice that there is some danger of losing sight of the fundamental ideas of treatment which led Owen Thomas to devise the splint. Thomas originally devised his knee-splint to give effect to his belief that the treatment of a diseased knee-joint demanded absolute rest without any impediment to the circulation of blood through the diseased part, and without tension on the diseased tissues.

The last of these points was the one to which Thomas drew very particular attention ; indeed, in his writings he vehemently attacks those surgeons of his day who advocated attempting to fix joints by employing weight and pulley extension, on the ground that putting tension on diseased tissues can only be harmful to them.

All these fundamental principles of treatment are equally applicable to the treatment of fractures. Hence the Thomas knee-splint became adopted as the most convenient splint for the fixation of all fractures of the femur below the level of the lesser trochanter, and for many fractures of both bones of the leg in which maintenance of rest by local splints alone is found difficult or impossible.

The advantages of the splint are : (1) It provides means of controlling the limb by obtaining points of support above and below the injury without having to employ bandages which cause circular constriction of the limb and therefore more or less definite interference with circulation in the injured part. (2) It furnishes means of fixing the limb longitudinally without continuous tension on the tissues about the fracture such as occurs in extension by weight and pulley.

This absence of tension is particularly important in the treatment of septic compound fractures, for muscles and other soft parts which are subjected either to tension or pressure cannot be provided with that free circulation of blood and lymph which is essential to a successful resistance to the onslaught of septic organisms.

This raises the question of the influence of muscular action, especially with regard to the opinion apparently held by some surgeons that muscular action continues and tends to produce deformity. In the case of fractures the over-riding of the fragments and consequent shortening of the limb is attributed to continued action of the muscles, and it is therefore held that very strenuous endeavours must be made by means of 'extension' to overcome this tendency.

Thomas* himself, when dealing with the influence of muscles on

* H. O. Thomas, *Contributions to Surgery*, 1883, Part ii, p. 10.

producing deformity of joints, makes the following very definite statement: "When the bones comprising the joint have been carefully fixed, so that ordinary motion and tremor are avoided, the muscles in connection with the joint are quiescent."

This statement is equally true of the muscles crossing the seat of a fracture of a long bone, such as the femur. That is to say, the 'extension' apparatus, whether attached to the limb by adhesive strapping or by some modification of the ice tongs, is used merely to fix the length of the limb, not to maintain active extension.

When a Thomas knee-splint is bent at the level of the knee-joint, and the splint and extension apparatus attached to the thigh are suspended by means of weights and pulleys, the method of treatment is that of Hodgen, not that of Thomas. Every movement of the patient's body, which is the counterpoise to the weight extension, causes a variation of tension in the muscles of the thigh, and this keeps the reflex nerve-muscle apparatus awake, and therefore muscular action continues. With the 'fixed extension' imposed by Thomas the reflex apparatus does not remain awake.

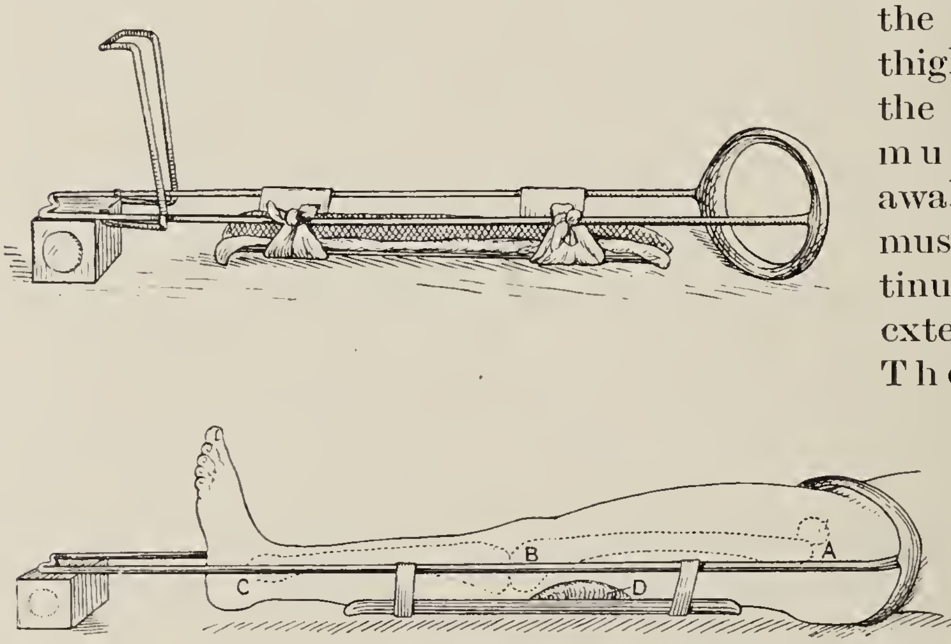


Fig. 122.—Thomas's Knee-splint and Gutter Back Splint.

(A) Posterior border of great trochanter, (B) Middle of condyle, and (C) Malleolus, all in line with side bar of splint; (D) Posterior pad of wool on gutter back splint in upper part of popliteal space.

Fixation of a fracture of a long bone as regards lateral and antero-posterior mobility can usually be secured by the use of local splints. Longitudinal fixation has always been the problem, especially in the lower limb. The Thomas splint is an excellent one for this purpose when properly used. *Figs.* 114–117 and *Fig.* 123 illustrate the method of procedure. With regard to the splint itself the padding of the ring should never be too thick, and the stouter the patient the thinner should be the ring.

Fig. 122 illustrates the apparatus for a simple uncomplicated fracture of the shaft of the femur anywhere in its middle and lower thirds. The writer treats fractures above the trochanter minor on an abduction frame, and fractures at or just below the lesser trochanter either on an abduction frame or a Thomas knee-splint, depending on the difficulty of controlling the upper fragment.

When in position, the posterior border of the great trochanter, the middle of the condyle, and the malleolus should be in line with the side bar of the splint. The upper end of the inner bar should be as far forward as the prominent part of the tendon of the adductor longus muscle, or even slightly in advance of it. Thus the middle of the hip-, knee-, and ankle-joints are kept in the plane of the side bars.

The extension strapping should be applied right up to the seat of fracture, taking as good a grip as possible above the knee, and the extension tapes should come off from the malleoli so as to pull exactly in the axis of the limb.

The padding on the posterior gutter-splint should be in the upper part of the popliteal space above the condyles. It is intended to maintain the normal anterior bow of the femur ; the condyles should be free of the lower end of this pad. Local lateral splints may be used as required ; in many cases they are hardly necessary after the first few days, and their absence enables the surgeon to keep his eye on the contours and shape of the limb, while the tape measure informs him if proper length is being maintained.

The traditional method of fixing the extension tapes to the bottom of the splint is shown in *Fig.* 117. One is taken in front of one side bar, and the other behind the other side bar, and the two made to cross in the dimple provided for the purpose at the lower end of the splint. On tightening these the ring of the splint is pressed firmly up against the tuber ischii, and when the tapes are tied the longitudinal fixation of the limb is complete. When the muscles become 'quiescent', which they should do within twenty-four hours, they relax, and therefore the surgeon must see that the tapes are made taut every day ; no screw apparatus is needed, for it is far too powerful, and will only cause pressure on the groin or else pull the extension strapping off the limb.

In cases where shortening is part of the deformity of a malunited fracture, any stretching of muscles should be done in the theatre after osteotomy has been performed, as part of the operation to correct the deformity. The limb is then fixed, as described, by hand, in the best length obtainable.

The square block shown in *Fig.* 122 serves two purposes : it keeps the side bars in the same horizontal plane, and also keeps the patient's heel off the bed.

The foot-piece shown is a simple form which is convenient, but there are many useful varieties to choose from.

In the case of septic compound fractures such as occur in war the simple posterior gutter splint shown is not suitable.

Some surgeons have adopted the plan of supporting the limb by transverse strips of flannel. These allow of good adjustment of position, and can be removed one at a time for dressing. The writer's objection to this method is that these transverse bands get very

dirty with discharges. They must be removed for dressings, and the nurse may not always adjust them exactly as they were left by the surgeon. To avoid this trouble in septic war wounds the writer used perforated zinc splints, pierced, if necessary, for irrigation tubes or drainage tubes, and all dressings for the absorption of discharge were put on outside the zinc splints, which served to immobilize and steady the soft parts. The result of this firm control of the soft parts was excellent.

It is interesting that Winnett Orr in America has gone further, and boldly encases the whole limb in plaster after cleaning the wound and packing it with paraffin, on the ground that the soft parts require steady, uniform support just as much as the bones.

Thomas's Bed Splint.—This splint is simply a form of Thomas's knee-splint, and is admirably adapted for treating all fractures of the lower extremity above the lower third of the tibia and fibula. It consists of a padded hoop which should fit snugly round the upper part of the thigh, obtaining its purchase from the tuberosity of the ischium. From the hoop two parallel iron bars descend, and are joined together below by a short cross-piece with a central notch. The splint should reach from the buttock to 8 in. below the sole of the foot. At necessary intervals there are cross-supports of flannel, webbing, rubber, or perforated zinc—according to the requirements of the case—which afford support to the limb, or a gutter back splint may be employed.

The extension strapping is applied in the ordinary way, but to the lower free ends of the lateral straps strong linen bandages are secured by firm knots. The limb is introduced into the splint from above, and the padded ring is pushed well home against the ischial tuberosity; the extension bandages are pulled tight, and secured to the notch of the cross-piece at the lower end—one bandage passing above and the other below the lateral irons—where finally they are firmly knotted.

The cross-slings are now adjusted so that the limb lies easily and comfortably with adequate support. It is very important to bear in mind that the femur has a natural convexity forwards. In order to preserve this anterior curve, the backward sagging which commonly occurs is to be prevented. When the limb is properly fixed, a distinct rounded curve should be obvious when the line of the limb is inspected from the side.

The advocates of this method of treatment claim: (1) That the apparatus can be fixed without the administration of an anæsthetic; (2) That it is suited to all kinds of fracture; (3) That the fixed pull gives continuous rest to and steadies the muscles better than the weight and pulley; (4) That even in fractures near the knee-joint backward displacement is easily corrected.

Each day the pull of the extension should be tested, and an extra half to one inch can be gained by further pulling on and tightening the bandages, until all shortening has been overcome.

A foot-piece which maintains the foot at a right angle is easily fitted, and is a distinct advantage. When the splint is used for fractures of the tibia and fibula, the extension strapping is, of course, applied up to the point of fracture only.

Thomas's Walking Caliper Splint.—Thomas's walking caliper is an ambulatory variant of the knee-splint. It is intended to give a certain amount of fixed extension while allowing the patient to walk. The lower end of the splint is turned into a socket in the heel of the boot, and lacing the boot fixes it. Flexion at the knee is prevented by anterior straps above and below the patella, and the back of the upper end of the tibia rests on a broad posterior strap (*Fig.* 123).

This splint has many uses. Originally intended for the later stages of the treatment of tuberculous disease of the knee, it is now used by many surgeons as a routine for all fractures of the femur. A case of simple fracture may get up and walk in this splint at the end of six or eight weeks after his accident, and the later stages of consolidation proceed without fear of deformity being produced, because the patient is really sitting on his tuber ischii on the ring of the splint.

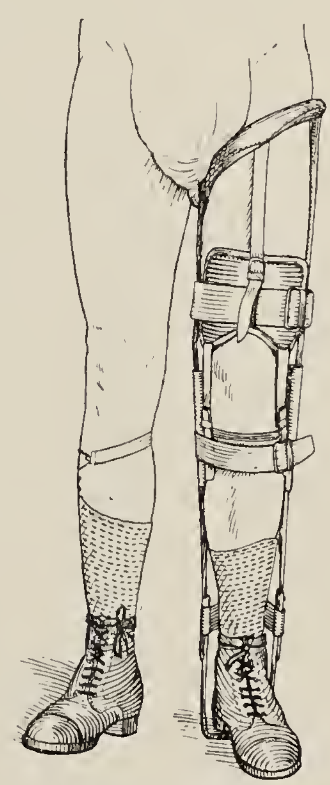


Fig. 123. Thomas's Walking Caliper Splint.

This splint is peculiarly useful in ununited fractures of the femur. These are almost invariably transverse fractures with the fragments in end-to-end position, if cases of gunshot wounds in which a large part of the bone has been shot away are not counted. The writer can remember no case of oblique fracture or of fracture with over-riding of the fragments which persistently refused to unite.

If cases of fracture of the femur which have remained ununited for months are fitted with a walking caliper, and are made to walk in it, a surprising number will unite without the necessity of an open operation. This is particularly useful when owing to recent sepsis the surgeon hesitates to perform an operation.

In children with infantile paralysis it affords an easy means of stabilizing an insecure knee-joint, first making the patient independent of crutches, and next giving the limb a physiological stimulus to its growth which greatly diminishes the ultimate disparity in length.

Finally, the Thomas walking caliper can be used as a groin crutch for patients who have an ununited fracture of the neck of the femur. The frequency with which only fibrous union occurs after such a fracture in old people is notorious. Attempts to walk strain the fibrous union, thus causing pain ; this can be relieved by fitting the patient with a caliper splint which carries much of the weight on

the tuber ischii and not on the injured neck. In such cases it is better to fit a leather top like the top of an ordinary bucket-bearing artificial limb instead of the ordinary ring, for these patients generally have to wear the splint for a long time. The splint has similar uses in any condition about the hip in which the strain of weight-bearing may cause pain or deformity.

HODGEN'S SPLINT.

Hodgen's splint (*Fig.* 124) is an apparatus devised particularly for cases of fractured femur in which it is desired to apply extension in the flexed position of the limb. It is thus peculiarly adapted for fractures in the neighbourhood of the lesser trochanter and in the lower third of the bone. In the former the upper fragment is flexed at the hip by the ilio-psoas, and in the latter the lower is flexed at the knee by the gastrocnemius ; in neither case can the smaller fragment be controlled, so that the larger one must be brought into its line. This splint is preferable to an inclined plane, because it does not impede nursing manipulations, and the patient can to a certain extent move about and even assume a semi-recumbent position without the risk of displacing the fragments.

The splint consists essentially of a stout wire frame shaped to fit the limb, and bent at the knee to an angle of 130°. There is a cross-bar at the upper end which corresponds to the fold of the groin, and a transverse one at the lower end. The frame should be long enough to extend from the anterior superior iliac spine to a point six inches below the sole of the foot. At four points on its upper surface hooks are fixed, one at the middle of the thigh-piece and one at the middle of the lower half, on either side. From these hooks stout cords are taken to a central pulley, from which in turn a single cord is led over a second pulley attached to a foot-piece at the end of the bed. The limb is suspended from the frame by broad strips of house-flannel, which are fixed with strong safety-pins to its two sides. The method of application is as follows. When it has been decided that the case is a suitable one for treatment with a Hodgen's splint, the house surgeon's first care should be to see that everything which may be necessary is at hand ; if this is not done, inconvenience will ensue and time will be lost. Thus, an ordinary stirrup for extension must be prepared, with side-pieces of strapping which are just long enough to reach from the stirrup to the site of the fracture, and a sufficient number of transverse pieces must be ready. A wire frame of the correct size must be procured, and it is well to see that the pulley and all the cords are in working order. Ten or twelve pieces of house-flannel should be cut about four or five inches broad and one foot in length : and lastly, an iron standard with a pulley must be attached to the foot of the bed.

It is advisable in all cases to give an anæsthetic, for two reasons : (1) the application of an extension stirrup is in itself a painful

business ; and (2) it is easier to obtain good position of the fragments when the muscles are relaxed.

When the patient is anæsthetized, the extension stirrup is applied. The method of application is similar to that employed when a Liston long splint is used. It must be remembered that the upper end of the side-pieces of strapping should reach just up to the site of the fracture. The transverse pieces of strapping should be applied round the leg so as to overlap from below upwards, extending from a point three inches above the malleoli to the level of the fracture, leaving out the knee-joint. A flannel bandage should be applied over all. The stirrup when held taut should be three inches from the sole of the foot. A short cord is passed through a hole in the centre of the stirrup, and is knotted on its proximal side.

The wire frame is now held over the limb, and the portions of house-flannel are passed underneath and pinned to the splint on either side, so as to form, as it were, a trough for the limb. They should extend from the heel to the gluteal fold, and their edges should be in apposition but should not overlap. The cord which has been passed through the stirrup is tied to the lower cross-bar of the splint. The four cords on the upper surface of the splint are adjusted to the pulley. Those leading from the thigh-pieces should be half as long again as the other two. The single cord which leads away from this is pulled over the pulley on the standard until the leg is raised about one foot from the foot of the standard.

So far everything is comparatively simple, but it is the subsequent adjustment of the apparatus which is all-important to the patient's comfort and alone can ensure a good result. These details can only be learnt by practical experience.

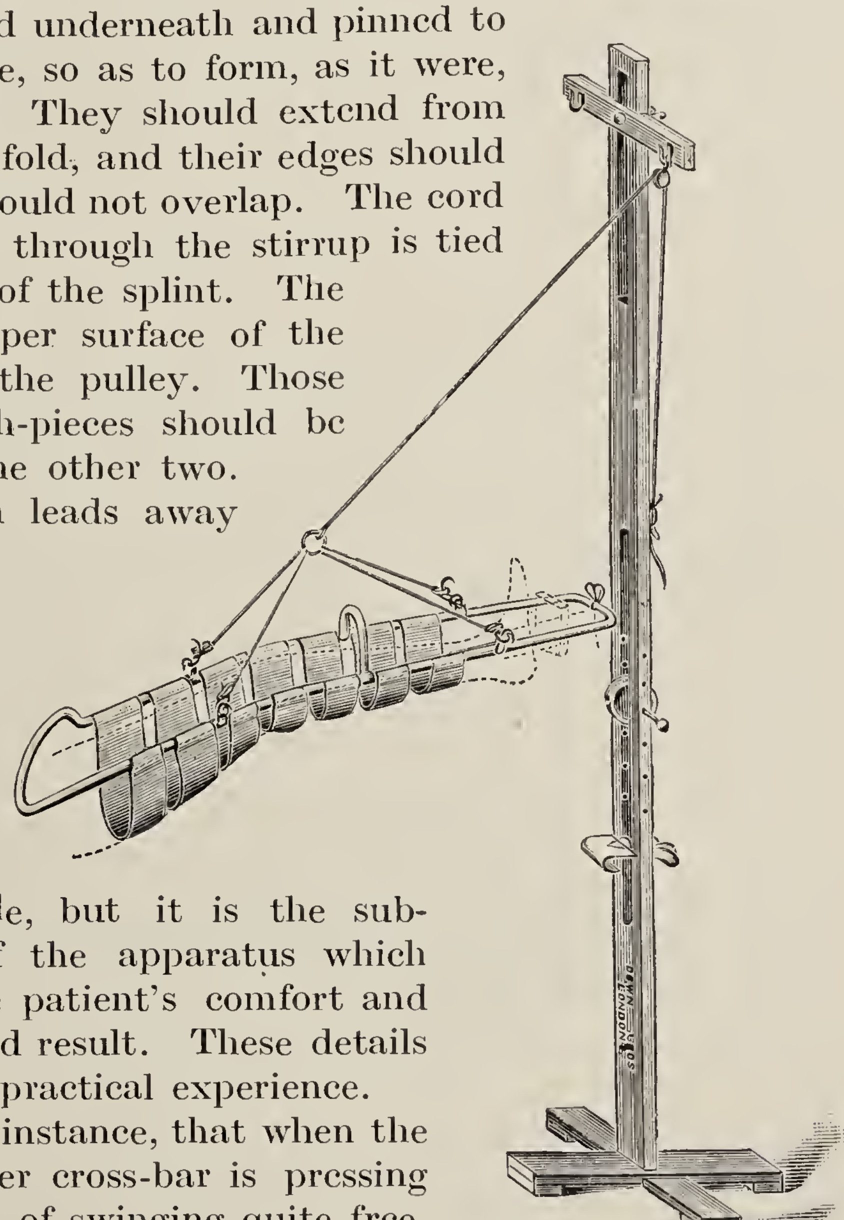


Fig. 124.—Hodgen's Wire Splint and Apparatus Complete.

It is often found, for instance, that when the limb is raised the upper cross-bar is pressing upon the groin, instead of swinging quite free, as it should do. This can be remedied by tightening the house-flannel under the thigh. As soon as the limb is raised, all the pieces of flannel should be examined, and tightened to the same degree, so that the weight of the limb is uniformly distributed. Another point to be

observed is that the direction of the short cords leading from the thigh-pieces to the central pulley should be in the line of that leading from the central pulley to the standard. This is simply a matter of arranging the height of the pulley on the standard. They need not, however, be in line with the femur, since the splint acts by producing extension upon the thigh in the semiflexed position, the extending force being the weight of the limb. Eversion is easily corrected by placing the foot upright, the friction between the house-flannel and the bandage being sufficient to retain it in that position.

One last word of warning. The Hodgen splint is an excellent apparatus if the treatment is properly carried out; but it is not sufficient to apply it once and never look at it again. The entire apparatus must be overhauled daily, the interdependence of its several parts adjusted, and the position of the limb attended to. If this is conscientiously done, excellent results will be obtained.

It will generally be found that the strapping begins to loosen at the end of three or four weeks, but by that time the extension will have done its work, and the limb can then be taken down and put up in a silicate bandage.

THE PATELLA.

This fracture, which usually results from muscular action, is in most cases treated nowadays by open operation, and the various methods of securing the broken fragments will not be here considered. Splint treatment should be applied to those cases which are not suitable for operative interference. Cases which fall under this category are the following: (1) Most cases of stellate fracture or of fracture produced by direct violence; (2) Fractures in alcoholic subjects or in those whose constitution is unsound as the result of renal or cardiac disease. It must

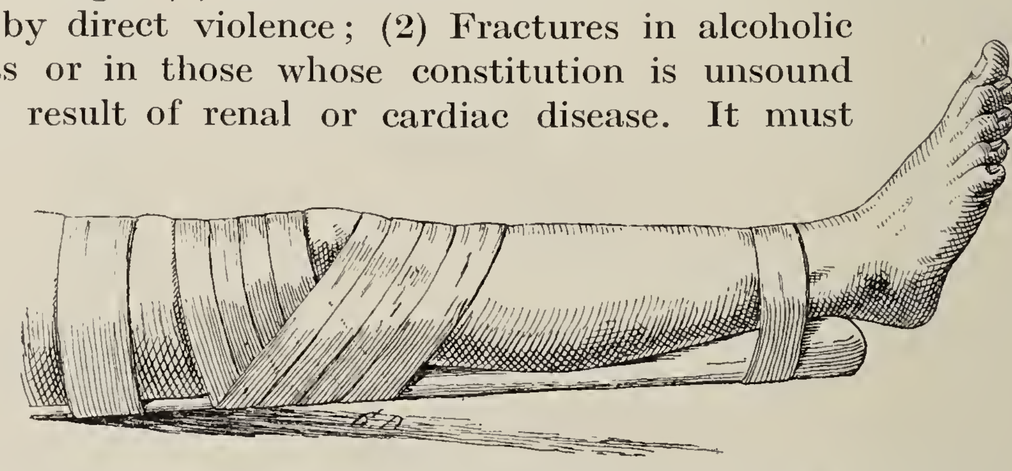


Fig. 125.—Fracture of the Patella treated by a simple Back Splint and Strapping.

be clearly understood that an operation on the knee-joint is a severe test of the recuperative powers of the tissues of a patient, and he should not be subjected to such an ordeal unless there is a very reasonable chance of success. The non-operative treatment consists in first placing the limb on a well-padded posterior splint extending from the hip to the heel (*Fig.* 125). The splint should be raised so that the hip-joint is flexed, in order to relax the rectus femoris. As

the joint will in all probability be full of blood, it is advisable to accelerate the removal of the latter, either by aspiration, which must be conducted with every aseptic precaution, or by massage, or by both massage and elastic compression. The massage should be employed for fifteen minutes twice a day.

As soon as the swelling has subsided and the surgeon is able to locate and approximate the fragments, they should be drawn together by means of a piece of strapping, which is fixed above the upper fragment in the form of a loop. The lower fragment is similarly pushed up by another strip. Either this method, which consists practically in bringing the fragments into apposition by strapping in the form of figure of 8, or the Middlesex Hospital method, should be employed. In this latter form of treatment the limb is placed on a long posterior splint with a firm foot-piece (*Fig.* 126), and a broad band of strapping is fixed across the limb just above the upper fragment. From the lower lateral borders of this band two long strips descend parallel with the leg, and then are connected to the foot-piece of the splint upon which the limb is resting by means of elastic bands, which exercise continuous elastic traction on the upper fragment.

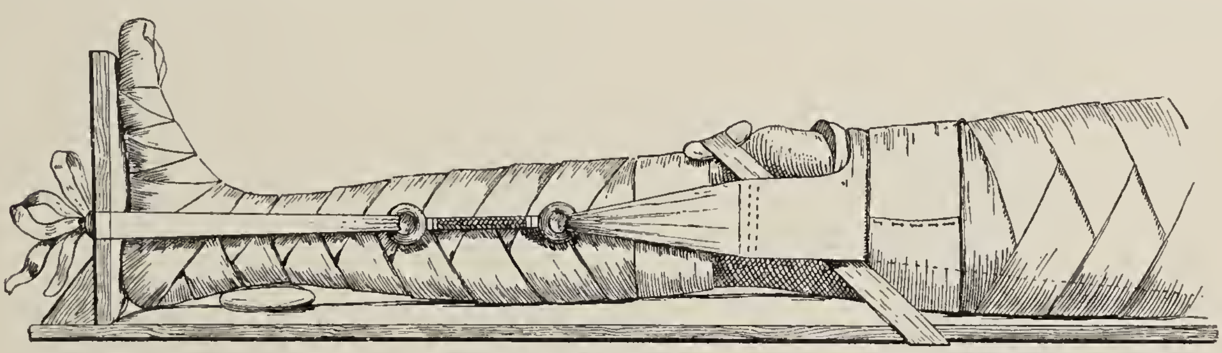


Fig. 126.—Middlesex Hospital Method of treating a Fractured Patella.

The whole limb is raised so as to relax the rectus femoris. The special object to aim at is accurate coaptation of the two bony surfaces without tilting, and as far as possible without the intervention of the torn aponeurosis. The chief objection to such treatment is the fact that it interferes with massage and passive movement, for under these circumstances the limb must be kept at rest for a period of six weeks, and only the muscles of the thigh can be subjected to daily massage. Lucas-Championnière does away with most retentive apparatus, allowing the patient to walk with the aid of a stick in from six to twelve days. From the onset of the injury until firm bony union is obtained, massage and passive movement are energetically performed. Under ordinary circumstances the house surgeon will find that a sufficiently good result will be obtained if the fragments are merely approximated by strapping, the limb being massaged daily, and gentle flexion of the joint started about the tenth to the fourteenth day. The upper fragment should be steadied by the surgeon's hand while these movements are being carried out, and at first it is advisable to flex the limb only to a very limited extent. The patient may be

allowed to walk on his leg within a month, but it should be supported by a poroplastic, leather, or plaster case. As the limb gains strength, greater freedom of movement may be permitted, but as a rule some form of retentive splint is required permanently.

THE BONES OF THE LEG.

These are the commonest fractures met with in the surgical wards. Either one or both bones may be broken, and the general treatment is similar in each instance. Fractures may be considered in the middle and upper third, and in the lower third, and Pott's fracture of the fibula will be described among those occurring in the latter group. The fracture is often oblique, and there is some difficulty in manipulating the fragments into good position and in keeping them there. There is a tendency for the lower fragment to be drawn up by the contraction of the gastrocnemius and soleus, and the house surgeon will find that considerable success will attend his efforts if he flexes the knee in order to relax these structures. He must also bear in mind that it is the lower fragment which is the mobile and displaced bone, and no amount of padding applied to the projecting upper fragment can have any effect in rectifying the malposition. The lower fragment is to be manipulated into apposition with the upper fragment, and it may sometimes be necessary to invert the foot, to flex the knee, or even to divide the tendo Achillis in order to obtain this end.

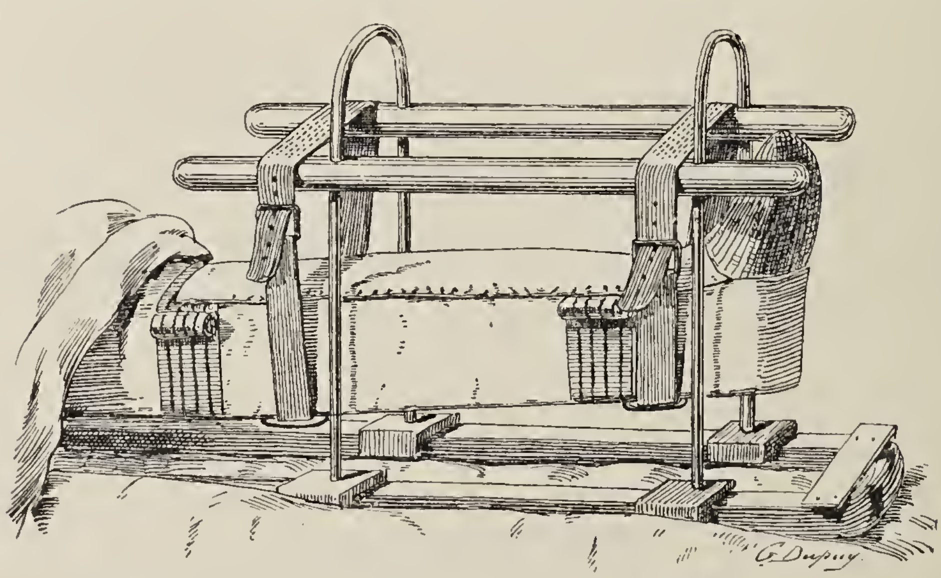


Fig. 127.—Fractured Leg slung in a Box Splint.

In cases uncomplicated by much swelling or deformity the fracture may with advantage be put up in a plaster case, which can be taken down for massage and passive movements at the end of a few days. This is a form of treatment applicable to hospital patients, who can then hobble about on crutches and attend the hospital for the massage as arranged. If, however, the swelling is excessive and the tendency to displacement great, the patient should be admitted, and the limb put up under an anæsthetic in a box or Nevill's splint, and slung so that the posterior leg muscles are relaxed. In some cases a M'Intyre's splint may be substituted. (*See Figs.* 67, 68, 69, 127.)

Extension apparatus is the only resource if there is much spasm of the muscles, but it is exceedingly difficult to apply strapping round

the ankle for a weight extension without the production of œdema. The best way of obtaining the extension is to fit an old tennis shoe or slipper on to the patient's foot, and fix the extension apparatus to this.

In favourable cases, the patient may leave off the splint in about six weeks, and after another fortnight, during which he accustoms himself gradually to bear the weight of his body on the limb, he can walk about.

The method of *immediate splinting* described by Croft, or some modification of it, has come into very general use, as it has all the advantages of the Bavarian splint in the way of being able to be opened for inspection of the limb, and is yet much simpler. Each splint (for the leg two will be required) consists of two layers of house-flannel. The inner layer, which is generally moistened with water, is applied to the limb, while the outer one is thoroughly soaked in plaster-of-Paris cream and put on over it. Both layers are now moulded to the limb while the surgeon holds it in position. *Muslin* bandages are then rolled on so as thoroughly to shape the splints and bind them together. The turns of the bandage adhere to the plaster;

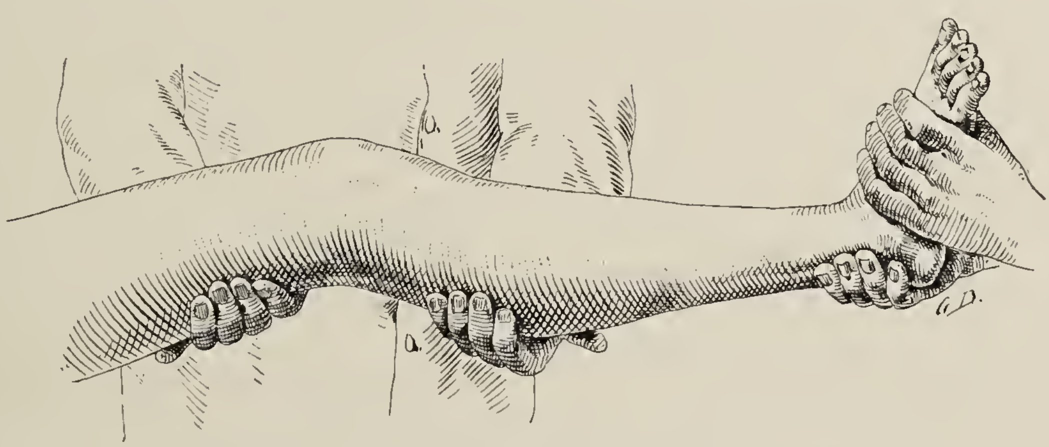


Fig. 128.—Supporting the Limb for Immediate Splinting.

but as the interval between the various splint pieces is spanned by muslin only, this can be cut up for examination of the limb along the upper interval, while it serves as a hinge at the lower. In the case of fractures of the leg, the pattern for the pieces of flannel, as in the case of the Bavarian splint (*see Plates I and II*), can be got from the flattened-out stocking of the patient. Inside and outside splints will here be required, and they must be cut of such a size that they will not meet in front or behind by about half an inch. This plan of splinting can be adopted in many different forms of injury, and to various parts of the body.

While the case is being applied, the limb must be most *carefully held in position* (preferably by the responsible surgeon) (*Fig.* 128), for upon this the whole success of the treatment will depend. After the case has set, it will generally be advisable for the patient to remain in bed with the limb raised for at least the first week; but in any event the period of confinement to bed will be much shorter than upon the old plan. Other fractures in this class are sometimes

best treated by the back splint and swing cradle, to be presently described.

Treatment by means of the Box Splint.—This plan consists in putting the limb up upon a back splint and with side splints, and swinging the box thus formed from a cradle (*see Fig.* 127).

1. *The Back Splint.*—This is the kind known as '*Neville's Splint,*' and consists of a plain piece of iron, with cross-pieces for the leather bands by which it is swung ; it should be perforated along the sides to allow of the pad being sewn on, and bent up below to form a foot-piece ; it has, as well, lesser curves for the swell of the calf and the bend of the knee. *Fig.* 67 represents Neville's splint, and although its application really is simple enough, still there are many small points which must be attended to.

In choosing the splint for a given case, the important points are :—

a. It should be fully broad enough, lest the bandage or side splints should compress the leg too tightly.

b. The foot-piece should be bent up quite at right angles to the leg-piece.

c. The length from the foot to the bend for the knee should correspond to that of the *sound* leg.

d. The thigh-piece should be long enough to enable the bandage to take a firm hold of it.

e. The bend at the knee must not be less than 160°.

2. *The Padding* of the back splint must be firm and even, and especially smooth about the heel, where the possibility of a sore being formed must be kept in mind.

3. *The Side Splints* must be well padded, and should be simple, straight, wooden ones, reaching from just above the knee to the edge of the foot-piece. At the foot there should be a short broad strap and buckle, which serves to fasten the two together, the strap passing just below and round the foot-piece (this strap is often omitted).

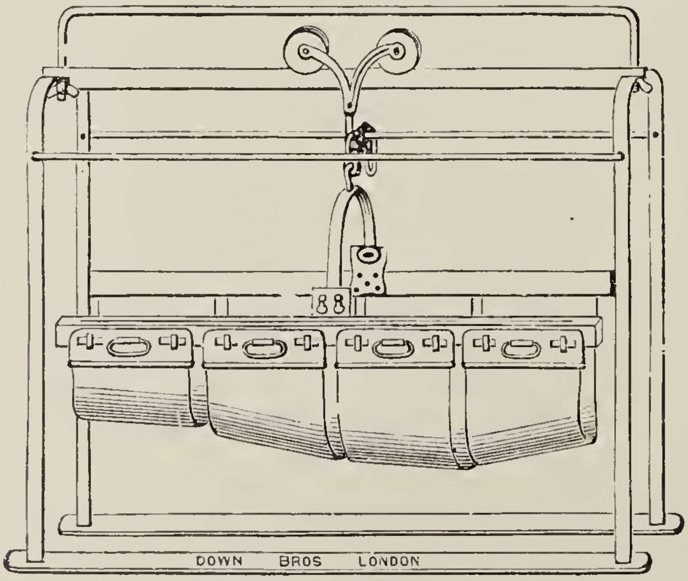


Fig. 129.—Salter's fixed Cradle with Swing.

4. *The Swing Cradle.*—All fractures bad enough to require careful back splinting are bad enough to be swung. Neglect of this is a frequent cause of bad position. The simplest plan is to pass leather straps through the slits in the cross-piece of the splint, and sling it to the cradle, as illustrated in *Fig.* 69.

There are many other forms of cradles, and one in great favour is that called after Salter (*Fig.* 129). In this, as is seen in the figure,

the leg is supported in a canvas trough, and the back splint is not fixed to the straps.

The apparatus being ready, the limb must be fastened to the back splint; the whole difficulty of obtaining a good position lies in the necessity for keeping up extension and a slight amount of inward rotation while this fixation is effected. In difficult cases, or where there is much spasm or pain, an anæsthetic should be given, and its action pushed to complete flaccidity of the muscles.

One assistant should now grasp the limb about the knee, and rolling it slightly inwards, must be prepared to make counter-extension when required. The surgeon, then taking hold of the foot and ankle, will generally be able, by making extension, to get the limb into its proper position.

While the limb is thus extended, it must be settled on the splint and fastened to it, and great care must be taken to keep the plantar surface of the heel well against the foot-piece, with the foot turned slightly inwards, and the hollow above the insertion of the tendo Achillis into the os calcis properly supported. No point in the setting of the fracture is more important than this, as will be understood from what has been said before about the disaster of a sore heel. The readiest road to security in this respect is to have a store of small pads at hand, from which those can be chosen which will best support the hollow beneath the tendon, so that the point of the heel is free of, or only just touches, the splint.

This 'fitting' of the foot and ankle finished, and a final look given to see that the upper bend of the splint corresponds to the knee, the limb, still held extended in position, is settled upon the rest of the splint. If a second assistant be at hand, the task of fastening the limb to the splint may be entrusted to him, while the surgeon and the first one keep up the extension. But if, as often happens, one person only is available, the foot must be held by him with one hand while the first few turns of bandage or strapping are made with the other.

In any case the limb must be fastened to the splint very carefully; the heel must be kept down and the foot straight, while very possibly the skin has been bruised, and certainly all the parts are tender. In many cases one or two strips of adhesive strapping may be applied with great advantage round the foot and ankle, great care being taken that they do not strangulate the part, the risk of which is lessened if they are applied with a piece of lint between their surfaces and the skin. In the same way it is advisable to pass a piece of broad strapping round the thigh and the splint upon which it lies.

But whether strapping be used or not, the foot and ankle must in every case be firmly bandaged to the splint, and then the upper part of the leg, the knee, and the lower third of the thigh must be fixed in the same way. No rule can be given as to the extent to which the bandage from the foot should be carried up the limb, but it is generally brought up to the vicinity of the fracture : never over it. This done,

in ordinary cases the limb will now be fixed in its proper position, and needs only to have the side splints adjusted and to be swung.

But very often some additional support is required, and further measures have to be adopted to maintain position. Thus, one of the fragments may persistently rise, and project dangerously near the skin; or the foot may rotate outwards, defying the action of bandage or strapping; or the heel may constantly come away from the foot-piece; or, as often happens, there may be a bowing outwards or inwards of the fragments, which simple extension does not overcome.

Directions for such conditions obviously cannot be given in any very precise form. One particular complication is so common, however, that it deserves special mention. The weight of the foot is apt to depress the heel, so that the upper end of the lower fragment is tilted forwards and may even damage the overlying skin. This is best overcome by fitting a sock on to the foot and elevating the heel by fixing the apex of the sock to the top of the foot-piece of the splint.

Pott's Fracture.—This is a fracture combined with a dislocation, there being a dislocation of the foot outwards at the ankle-joint and a fracture of the fibula about 3 in. above the external malleolus. In the more complicated cases the tibia may be broken as well, or the astragalus driven up between the two malleoli, so that they are widely separated. Complicated cases of Pott's fracture require the immediate supervision of the surgeon. Simple cases should be treated as follows:—

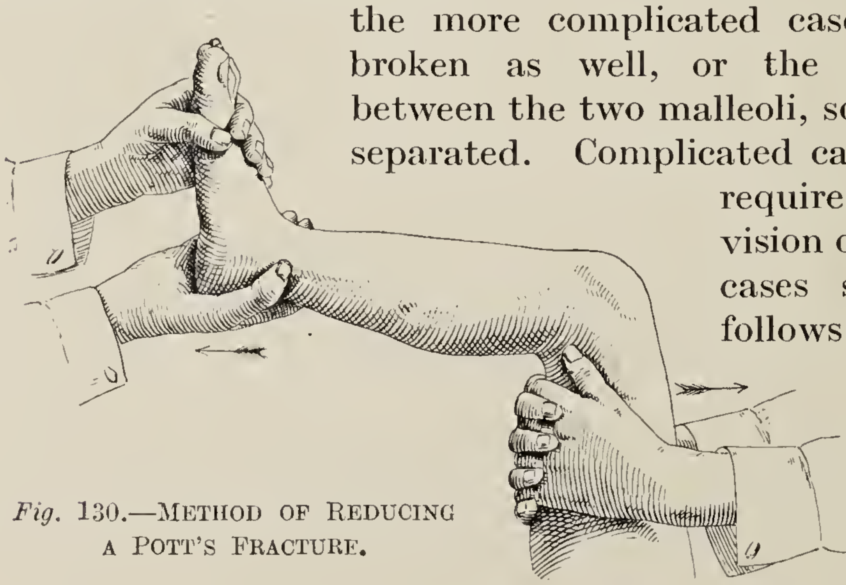


Fig. 130.—Method of Reducing a Pott's Fracture.

The displacement must be reduced, preferably under an anæsthetic, and a certain amount of time may be well spent as a preliminary in massaging the muscles which are in a state of spasm. In reducing the displacement, it is well to bear in mind the structures which assist in maintaining the deformity; these are the tendo Achillis and the muscles which form it, and the peroneal muscles, which drag the heel backwards and the foot outwards. The first step, therefore, is to flex the limb at the knee, for by this means the tendo Achillis is relaxed; an assistant should steady the flexed knee while the surgeon grasps the foot and heel, the left hand taking the anterior part of the foot, the right hand the heel (*Fig.* 130). The foot is now forcibly twisted inwards, whereby the displaced surface of the astragalus is brought into its normal position beneath the tibia, and at the same time the heel should be pulled forward and the foot flexed at the ankle-joint to a right angle or even beyond it.

There are two 'poor results' which must be guarded against at

this stage. The first is a recurrence of backward displacement, which is most often seen if the posterior edge of the tibia is broken off (this can be diagnosed only by the X rays). The other is flat-foot. The former is avoided by fixing the limb in plaster with the foot at a right angle, and the latter by combining with this position a slight degree of varus.

If the displacement can be corrected readily and the amount of swelling present is slight, the limb may be put up in a plaster-of-Paris splint extending from above the knee to the middle of the foot, but this must not be applied if it is found that the extended position tends to reproduce the deformity. If the splint has been fitted, the limb must be massaged daily, and each day a careful observation must be made as to the position of the limb. From the fourth day onwards, passive movements to prevent adhesion in the joint and tendon sheaths should be undertaken, and during this time the patient is able to hobble about on crutches without injury. Active movements should be permitted at the end of three weeks, and the patient may put his weight on the injured foot during the sixth week, provided a suitable boot be worn (*see below*), but a careful watch must be kept for any sign of displacement outwards, in which case the splint must be reapplied and the walking prohibited.

When the displacement is more marked, the swelling greater, and the reduetion is attended with greater difficulty, a box-splint may be applied after the limb has been manipulated into a satisfactory position. The Dupuytren's splint which used to be recommended for these cases is not satisfactory, as it is impossible with this splint to obtain the necessary dorsiflexion of the foot. If there is great resistance to the reduction of the deformity, the tendo Achillis may be divided. During the daily inspection of such a case attention must be specially paid to the position of the heel, since it is exceedingly liable to be drawn upwards, and bad results ensue unless special means are taken to prevent it. At the slightest sign of upward displacement, the malposition must be rectified and the knee flexed to a more acute angle.

The other deformity which is likely to recur is the displacement outwards, or valgus. This must be attended to in the same way, the slightest tendency to malposition being immediately rectified. Massage and passive movements are to be undertaken as in the former variety, and the patient must be eneouraged to invert and dorsiflex his foot voluntarily so as to prevent any further displacement.

In bad fractures it is necessary to keep the patient from walking for a somewhat longer period—eight to ten weeks—but from the third week onwards active movements of flexion and extension should be encouraged, as before.

Too often, bad results occur because the patient is allowed up too soon. Putting weight on the limb before the callus is firm strains the callus and the ligaments and develops a progressive flat-foot.

Every case of Pott's fracture should be fitted with a special boot, the inner side of sole and heel a third of an inch thicker than the outer, and with a bracing iron attached to the outer side (*Fig.* 131). This apparatus protects the callus and keeps the foot in a position of varus.

In all fractures of the lower extremity, a varus (bow) position at the knee and ankle results in security, a valgus in weakness.

Another not uncommon fracture in the region of the ankle is a fracture displacing the posterior edge of the tibial articulation; this is often accompanied with a splitting of the fibula and damage to the anterior edge of the tibial articular surface. The astragalus and the whole foot are displaced backwards. Swelling, often excessive, masks the true deformity, and the backward displacement is never corrected. The case is considered to be one of 'Pott's fracture,' and the inversion is obtained without overcoming the true deformity; the final functional result is bad. The occurenee of such cases is a further proof, if such were needed, of the necessity for X-raying all fractures; for when the position of the fragments is made out, by flexing the leg at the knee and pulling the heel and foot forcibly into dorsiflexion, the displacement can be reetified; the subsequent treatment is the same as in Pott's fracture, but special pains must be taken to secure full dorsiflexion of the ankle.

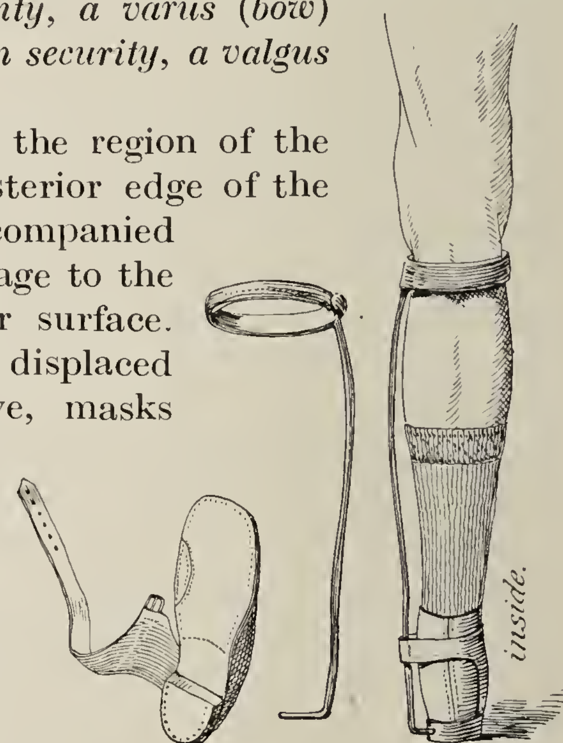


Fig. 131.—Diagram of Boot and Splint for Preventing Flat-foot.

Fractures of the Bones of the Foot.—These fractures do not call for any special attention. They are diagnosed by means of the X rays, and the broken bones must be manipulated to the best position under the circumstances, with due attention to the normal position of the foot in relation to the leg. A plaster case should be applied, and massage and passive movement used as in the preceding variety. In six to eight weeks union is satisfactory.

SEPARATED EPIPHYSES.

The injuries which are considered under this special head are due to damage to the bone in the region of the epiphyseal or growing line; in most cases the actual injury is a fracture on the shaft side of the epiphysis, or, as it has been called, juxta-epiphyseal separation. They are therefore confined to the earlier periods of life before union between the two parts of the bone has been effected. The special importance of these injuries arises from the facts, first, that they lie in intimate relationship to the joints of the extremities, which are frequently involved; secondly, owing to the smallness of the epiphyseal fragment, reduction of the deformity is effected with

difficulty ; and thirdly, they may affect the growth of the bone and lead to distortion of the limb. The injuries are recognized by the following signs and symptoms : (1) The maximum signs of injury are in the neighbourhood of the epiphyseal line ; (2) The age of the patient is such that the epiphysis has not yet joined with the rest of the bone ; (3) The character of the crepitus is softer and less distinct than that in ordinary fractures. In most cases an X-ray examination is very necessary, since the injury is attended by so much swelling that it is not always possible to define the bony prominence correctly.

Reduction of the deformity is effected in the ordinary manner, by the application of extension and counter-extension ; but here difficulties may be encountered, since there are certain obstacles which oppose the satisfactory reduction in this particular type of injury. They are : (1) The interposition of muscle or tendon between the fractured surfaces ; (2) The rotation of the fractured epiphysis on an axis (especially is this the case in separation of the lower epiphysis of the femur) ; (3) The end of the shaft may be pushed through a hole in the periosteum, through which it cannot be withdrawn without an operation. Imperfect apposition nearly always leads to permanent deformity, and every attempt must be made to obtain a satisfactory position. It is not sufficient to rely upon nature in these cases.

The general rules as to displacement of epiphyses are as follows : There are four epiphyses which are especially liable to injury—the upper and lower end of the humerus, and the upper and lower end of the femur ; more rarely the epiphyses of the radius and tibia are injured. Although it is true that according to the direction of the violence which produces the injury the epiphysis may be displaced into almost any position, the tendency in the majority is for the shaft of the bone to be displaced towards the main vessel of the limb, so that in the case of the upper end of the humerus the resulting deformity is the same as that in fracture of the surgical neck, while at the lower end of the humerus the epiphysis is usually displaced backwards and the shaft forwards. In the case of the femur, separation of the upper epiphysis leads to much the same results as fracture of the neck of the bone, viz., that there is a tendency for the great trochanter to be pulled upwards by the action of the muscles attached to it, a condition which leads to progressive shortening and to the production of coxa vara. In fracture of the lower end of the femur, the epiphysis is displaced forwards and may be rotated, the shaft tending to impinge upon the popliteal vessels, which may be seriously damaged.

General Principles of Treatment.—An anæsthetic must always be given, and by extension and counter-extension the fragments must be manipulated as far as possible into their normal position.

Separation of the Upper Epiphysis of the Humerus.—The injury should be treated as a fracture of the surgical neck (*see Fig.* 99, p. 147).

A pad of wool of sufficient size is placed in the axilla, and the arm is bandaged to the side. Massage must be undertaken from the first, but passive movements in children need not be started quite so soon as in adults. They should be begun from the tenth to the fourteenth day, and of necessity in the majority of cases must be performed under anæsthesia. Union is usually firm at the end of six weeks.

Separation of the Lower Epiphysis of the Humerus.—In this injury either the entire epiphysis may be displaced, with or without diastasis of the various centres which enter into its formation, or the outer or the inner condylic portions only may be affected. The usual displacement is that the epiphyseal fragment is displaced backwards and inwards, the inward displacement being due to the falling over or pronation of the forearm, which carries the lower end of the humerus in with the twist. Uncomplicated cases, that is to say, cases not attended by a large amount of effusion, can be satisfactorily treated as follows. Under anæsthesia, the condyles and the elbow are grasped with the right hand, and the shaft of the bone with the left, while the whole of the upper extremity should be steadied by an assistant. The condyles are pulled down and manipulated outward. Keeping up the extension, the thumb of the left hand is pressed deeply into the antecubital fossa, so as to push the lower end of the shaft in a backward direction. The limb should now be put up in a position of acute flexion and supination, the hand resting on the shoulder of the injured side. By keeping the forearm in supination, the tendency to inward displacement of the separated fragment is overcome. The limb can be secured in this position by simple means, such as bands of strapping, bandages, or poroplastic splints, and it may be taken as a general rule that if the arm can be got into a position of acute flexion, all serious deformity has been rectified.

Massage may be begun from the first, that is to say the next day, but passive movements had better be deferred for ten days or more, and then undertaken with the greatest possible care, since if they are performed too energetically the deformity may be reproduced. As a rule, it is well to begin by rotating the radio-ulnar joint, and slightly extending the arm through a few degrees, the limb being put up after each sitting in a position of slightly reduced flexion. After two to three weeks the hand may be slung to the neck, and each day it is dropped an inch or so. If too vigorous movements are employed, it will be found that not only do they produce pain, but that they actually diminish the range of movement previously existing. This is due to straining and irritation of the callus. It cannot be too clearly emphasized that passive movements should not cause pain.

The cases, however, which give trouble are those associated with so much swelling and bruising of the parts that not only is correct manipulation of the fragments an impossibility, but flexion of the arm even to a right angle is attended by so much pressure on the tissues around the elbow as to render it dangerous. Anything in

the shape of excessive pressure must be scrupulously avoided, since such pressure even for a few hours may lead to such very serious complications as *ischæmic paralysis* and *gangrene*. These cases must be treated as follows: The child must be admitted into the hospital, and a gutter or trough of poroplastic material moulded to receive the injured limb. It should lie easily in this receptacle protected by cotton-wool, in a position flexed to as near a right angle as is possible without undue tension. Lint soaked in evaporating spirit lotion should be left in contact with the swollen parts, and gentle stroking massage should be undertaken from the first for ten or fifteen minutes twice a day. A radiograph should be taken to ascertain the exact state of affairs (*Fig.* 132), and as the swelling diminishes, the arm should be gradually flexed at the elbow until a position of acute flexion is obtained. A period of four to five days may elapse before the swelling diminishes sufficiently to allow the deformity to be completely rectified, and it is always advisable to bring such a case under the notice of the surgeon, since operative interference is often imperative.

Fig. 132.—Separation of the Lower Epiphysis of the Humerus.

When once the limb has been got into a position of flexion and the fragments are in a satisfactory position, the after-treatment should be conducted as in the previous variety, though passive movement may be undertaken on the third or fourth day after the position of acute flexion has been obtained. The fingers must be carefully watched during the first fortnight for signs of swelling, and above all the house surgeon must be on the look-out for any signs of ischæmic paralysis, which usually shows itself by an inability on the part of the child to extend the fingers, which remain flexed in a claw-like manner. In bad cases which are not operated upon, unsatisfactory results are bound to be obtained, but it is worth remembering that interference with full extension is usually less serious and less detrimental to a patient than interference with full flexion.

Separations of the lower epiphysis of the radius are treated on the same lines as Colles's fracture, the deformity of which is closely simulated by this injury.

Separation of the Upper Epiphysis of the Femur.—This can only be diagnosed with certainty by a good radiograph; but when great bruising attends a severe injury to the hip, together with loss of function of the limb and eversion, this injury must be suspected. An extension apparatus should be applied, and the case treated as one of fracture of the neck of the bone, massage being undertaken as before from the first, and gentle passive movements at the end of three or four weeks.

Separation of the Lower Epiphysis of the Femur. — There is great difficulty sometimes in reducing this deformity, owing to the swelling and to the rotation of the separated epiphysis, but an attempt should be made in the following way: The knee should be flexed to a right angle or beyond, and one broad band of webbing is placed round the upper end of the leg and another round the lower end of the femur. The foot should be held firmly by a special assistant, since the principle of the manœuvre depends upon using the foot as a fulcrum.

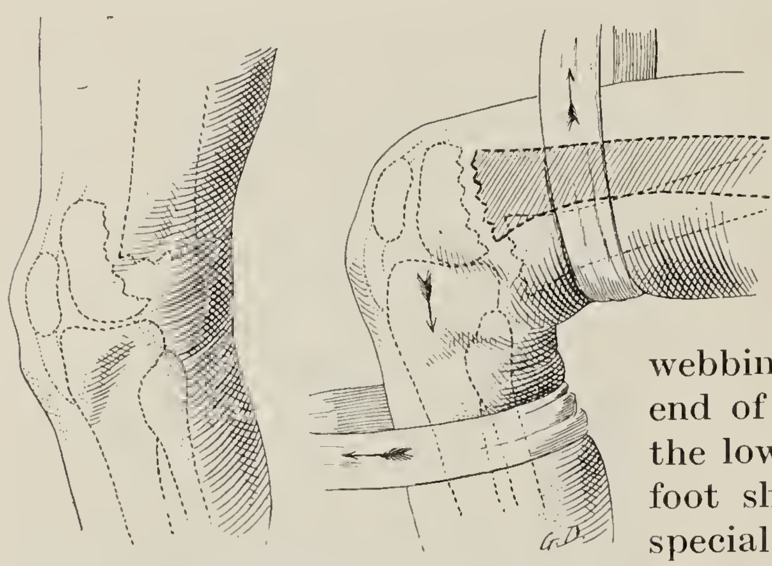


Fig. 133.—Separation of the Lower Epiphysis of the Femur.

Traction should be exerted at right angles to the long axis of the thigh and leg respectively; the pull should be directed in the case of the tibia directly forwards, in the case of the femur directly upwards (*Fig.* 133). The forward traction allows the displaced epiphysis to be drawn away from the femur, while the upward traction draws the shaft of the bone which has been displaced backwards into contact with the loose fragment. If the manipulation is successful, the limb should be flexed at an acute angle, as was the case with the lower end of the humerus, and fixed in this position.

Massage should be undertaken from the first, and gentle passive movements may be begun during the second week, the same precautions being adopted as in the case of a similar injury of the upper extremity. Anything in the nature of tight bandaging or tight compression is shown at once in children by swelling of the hands or feet, and on no account must it be allowed to persist, or irretrievable damage may be wrought to the vessels and the nerves of the limb.

CHAPTER XVII

INJURIES TO THE SPINE

INJURIES to the spine may result from direct or indirect violence. In the less severe cases there is a mere bruising of the muscles or stretching or tearing of the ligaments, both of which may be accompanied by a moderate degree of shock, swelling, and pain. So long as no actual signs of nervous injury are present, the case should be treated by rest, systematic massage for some weeks or months, and general tonics ; but it must be remembered that pain will follow movement of the damaged part for a very considerable period after all the active signs of the injury have subsided. Fracture, the more serious injury, is to be specially considered in connection with the associated damage to the spinal cord.

If the spinal column is subjected to violence, a condition may result which is sometimes called concussion of the spine. The symptoms of this lesion are somewhat variable and difficult to describe. Possibly pure concussion without gross lesion may exist, but more generally the term concussion is to be applied to a preliminary state of diminished activity of the central nervous system following a severe injury to the spinal column, from which the patient gradually recovers. These cases are most likely instances of hæmorrhage, either into the spinal cord or within the spinal membranes.

When the spinal column is fractured, there is usually associated with the fracture a dislocation or displacement of the bones of the column, which displacement may be temporary or permanent, for the column by virtue of its elasticity may be so displaced that the spinal cord becomes irretrievably damaged, but the bones may spring back into practically their normal position. In other instances the deformity or displacement persists, and a sharp angle is formed by the body of the vertebra immediately below the fracture, against which the cord is compressed or torn to a variable extent. Sometimes damage to the cord results from direct injury to the posterior part of the spinal canal, the laminæ being displaced forward, and such cases can of course be treated successfully by operation, since the immediate cause of compression can be removed. In the former cases, where the compressing agent is formed by the posterior surfaces of the bodies of the vertebræ, operative treatment is less successful, since all the operator can do is to remove the posterior wall of the spinal canal, and in very few instances is he able to rectify the deformed state of the vertebral body.

Fractured spine is to be considered under two headings : first, those

cases in which operative treatment of the injury is advisable ; and, secondly, those in which, owing to the presence of adverse symptoms, nothing operative must be attempted. Experience shows that a greater number of cases are now successfully submitted to operation than in former years, and since we know that in most instances paraplegia resulting from spinal injury is permanent unless treated, any treatment that holds out the smallest prospect of improvement should be employed. Following the injury, the nervous manifestations can be classified as follows :—

If the lesion is a total transverse one, there will be complete paralysis of the muscles below the lesion, which will be of a flaccid type, with loss of reflexes; and it may be said at first that the more completely the reflexes are abolished, and the longer the period which elapses before their return, the worse the prognosis and the more hopeless any attempt at operative treatment. Sensation below the lesion is abolished.

In partial lesions, there is a distinct difference according to whether the lesion is above or below the level of the second lumbar vertebra. Above that point the cord itself is damaged, and except for the particular nerve-root which may be affected at the seat of the injury, the paralysis tends to be of the upper segment type ; that is to say, there is a paralysis of the muscles which later becomes spastic, there is no reaction of degeneration, and the reflexes become exaggerated. On the other hand, if the lesion lies below this level, the nerves which enter into the formation of the cauda equina become involved, and the paralysis is of the lower segment type. The muscles remain flaccid, the reactions of degeneration become established, and the reflexes are permanently abolished.

Of course, many cases are met with which do not fall strictly into either category, owing to the extent and irregularity of the lesion. Injuries which involve the cauda equina should be distinguished from those which affect the spinal cord itself, because the cauda equina, being composed of mixed nerves, is capable of regeneration after injury and division, as are the nerves of the limb plexuses, though the results are not so satisfactory.

Effects on the Bladder.—It will be found that following most severe injuries to the spine, whether the lesion lie below or above the level of the second lumbar vertebra, for the first period at any rate the house surgeon will have to deal with retention of urine. In some cases, when the lesion lies above the bladder centre, which is situated in the lumbo-sacral region of the cord, there may be a certain return of reflex control, though it is exceedingly variable in its onset and in its extent. On the other hand, when the lesion lies below this level and affects the cauda equina, the tendency is for dribbling incontinence to set in as the case progresses, but this will not occur until some days or weeks have elapsed, during which the use of the catheter will be imperative, and it is one of the first details to be learned in the treatment of fracture of the spine.

When a catheter is required at regular intervals, the most scrupulous cleanliness is necessary to prevent cystitis, and this cleanliness is to be obtained in the following way : The penis and the meatus are to be thoroughly cleansed, and the former is to be enveloped in an antiseptic dressing. The catheter (preferably of rubber) is boiled before use on each occasion, and a non-irritating lubricant such as sterilized vaseline or olive oil is employed. The bladder is thoroughly emptied, and if this is not possible owing to the atonic state of the musculature, the interior should be washed out with weak boracic acid solution once a day. In spite of all these precautions cystitis may ensue. It must be treated by drugs, by lavage of the bladder, and in severe cases by drainage of that viscus. Ascending septic changes from the bladder to the kidneys are responsible for many fatal issues, and some surgeons advocate suprapubic cystotomy in the early stages so as to avoid this complication.*

Effects on the Rectum.—In many cases the sphincters are paralysed, together with the levator ani, the result being a loss of control over the contents of the bowel when they reach this region ; but as a matter of fact, owing to the co-existent paralysis of the abdominal muscles and the damage to the sympathetic nerves, the house surgeon will experience more difficulty in getting the bowels to act in the early stages of treatment than in controlling their action during the weeks which follow. Under no circumstances must he allow the tympanites to persist ; it must be treated by turpentine injections, fomentations to the abdomen, and suitable purges.

Bed-sores.—Cases which are not subjected to operation are exceedingly liable to develop this complication, which is responsible for a fatal issue in a large number. Only the most scrupulous care and patience will prevent this development, and cases of fractured spine may be looked upon as forming an excellent test of the character of the nursing in a given ward. For details of treatment, see Bedsores,' Chapter XXVI.

General Treatment of Cases not Submitted to Manipulation or Operation.—The patient should be put on a water- or air-bed, with the shoulders propped up so as to relieve the lungs, which are embarrassed in cases of injury to the cord high up owing to paralysis of the intercostal muscles. The patient is unable to expectorate, and death from some form of pneumonia is exceedingly common. Any actual deformity of the spine which is present must be protected from pressure by a ring pad or suitable appliance, and the patient must be turned regularly so that the same parts of his body are not subjected continually to a tiresome pressure. The bladder and rectum are to be attended to as before mentioned, and the greatest care must be exercised to see there is scrupulous cleanliness, since when incontinence

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* Probably the best way of treating these cases is the method advised by Kidd of tying in a catheter, with all due precautions, and changing it once or twice a week.

is present, the patient is very apt to be soiled by the discharges, which trickle away involuntarily. Pain is mitigated by opiates, and spasm of the muscles may be assisted by massage, but beyond this nothing can be done to remedy a condition which sooner or later must end in death. As a rule it may be said that the higher the injury the sooner the patient succumbs. In some cases death supervenes within a comparatively short time of the accident, probably from ascending inflammation of the cord. In other cases life may be prolonged for months and years if the process of degeneration is arrested and scrupulous care is taken.

Following injuries to the spine, paraplegia may come on at two distinct periods apart from that which immediately follows injury. A paraplegia occurring immediately after the injury is generally due to compression of the cord by bone, and may or may not require operative treatment. A paraplegia occurring within twenty-four hours of the accident is usually due to progressive hæmorrhage within the spinal canal, and is sometimes treated by operation ; while a paraplegia supervening at a later date (five or six weeks) is due to the formation of callus in the process of repair, and has been treated by operation with the most brilliant results. Such cases have, therefore, to be specially watched, for the development of a paraplegia in the later stages of an injury to the spine may require active surgical measures.

Fractures of the spine without compression symptoms should be treated on a Thomas frame—with a head-piece—and an endeavour should be made to maintain a position of dorsiflexion. This frame controls movement, and allows the patient to be moved easily. At least three months' splint treatment is necessary.

CHAPTER XVIII

OF DISLOCATIONS

CLASSIFICATION.—A dislocation is the partial or complete separation of one or more of the bony structures of a joint from the other or others.

Six varieties are recognized :—

1. *Complete*, when the bones are entirely separated from one another, e.g., at the shoulder or hip.
2. *Incomplete*, when the bones are still in apposition, but in faulty position, e.g., at the temporomaxillary joint.
3. *Compound*, when there is a wound of the skin.
4. *Spontaneous*, when the dislocation does not arise from violence.
5. *Congenital*, when from malformation the bones cannot remain in position.
6. *Pathological*, when arising from disease of one or both bones.

The first three of these are the classes that will be described, the latter three being of rarer occurrence, or associated with diseases of which the treatment does not come within the scope of this work.

A dislocation is recognized by the alteration in the shape of the joint, by one bone being felt in an unusual position, by an alteration in the length of the limb, and by impaired mobility of the joint. It must, however, be remembered that a fracture may co-exist with a dislocation, in which case care must be taken in handling the limb not to increase the damage to the soft tissues by the sharp ends of the bones. In doubtful cases the advantage of being able to take a skiagram is very great, and this should always be done where possible.

Very considerable damage to the soft tissues is always produced by a dislocation. The cartilages may be injured, the ligament and muscles much stretched if not entirely lacerated, and serious complications may arise from the displaced bone pressing on an artery, a vein, or nerves.

In reducing a dislocation, the object aimed at is to replace the bones in their natural position. The performance of this is, however, rendered more or less difficult by the tonic contraction of the muscles. It may be necessary to put the patient under an anæsthetic in order to overcome this contraction, especially in the case of strong muscular persons. The sooner, too, a dislocation is reduced the better, on account of this contraction of the muscles, for it has often been observed that the difficulty of reduction increases as time goes on. In certain cases the reduction is impeded by the anatomical structure of the joint and by the ligaments.

Methods of Reduction. — The reduction of dislocated bones may be effected by several means :—

1. *By Mechanical Means.*—Since the introduction of anæsthetics, by which relaxation of the muscles is obtained and the great obstacle to reduction removed, this method has fallen into disuse, except occasionally in the case of old dislocations. The force employed by the use of pulleys was very great, and it was not an unknown occurrence for a bone to break under their use.

2. *By Manipulation.*—During the last few years our knowledge of the anatomical relation of the parts concerned in a dislocation has been very much improved, and it has been found that by manipulating the limbs in certain directions—abducting and rotating in, adducting and rotating out, with extension as the case requires—most dislocations can be reduced without the force and risk of damage to the soft parts involved in the use of mechanical means.

It should be noted that when a dislocation is complicated by a fracture, it is usually advisable to perform an operation. Such injuries are likely to be followed by great impairment of function, and the attention of the surgeon should always be called to them.

SPECIAL DISLOCATIONS.

Dislocation of the Lower Jaw is generally bilateral, both condyles having slipped forward over the articular eminence into the zygomatic fossa, where they may be felt. To reduce it, the patient should be made to sit down on a chair or low stool ; the operator stands in front, and with his thumbs passed into the mouth presses the bone downwards and backwards, at the same time raising the chin (*Fig.* 135). As a rule the condyles slip back with a sharp snap, and, unless the surgeon has protected his thumbs by wrapping them in lint or some such substance, he may get them severely crushed between the teeth. The jaw should then be tied up with a four-tailed bandage, similar to that used in fracture of the jaw, and kept in that position for several days, the patient meanwhile being fed on slops.

Fig. 135.
Reduction of Dislocation of Jaw.

The Clavicle may be dislocated at either end, but the bone is far more frequently broken, owing to the very strong attachments to the sternum and scapula. The reduction is easily made, but considerable difficulty is experienced in retaining the bone in its proper position in the case of sternal dislocation. Having replaced the bone, a pad

should be firmly fastened on by a figure-of-8 bandage over the shoulders, and the arm fixed to the side. For an acromial dislocation the arm must be supported in a sling and drawn backwards, very much as a fractured clavicle is put up.

The displacement is very likely to recur, and in order to prevent this, the shoulder should be well covered with a plaster-of-Paris case, or plaster bandages, while the bones are held in good position. The plaster case must include and support the elbow, since the weight of the arm is the important factor in causing the recurrence of the dislocation. The casing must be kept on for three or four weeks, at the end of which time union should be firm and the dislocation should not recur. Many patients will be unwilling to submit to this prolonged immobilization, which is not without risk of causing stiffness in the shoulder; but where a permanent cure is desired, and operative treatment refused, it may be undertaken.

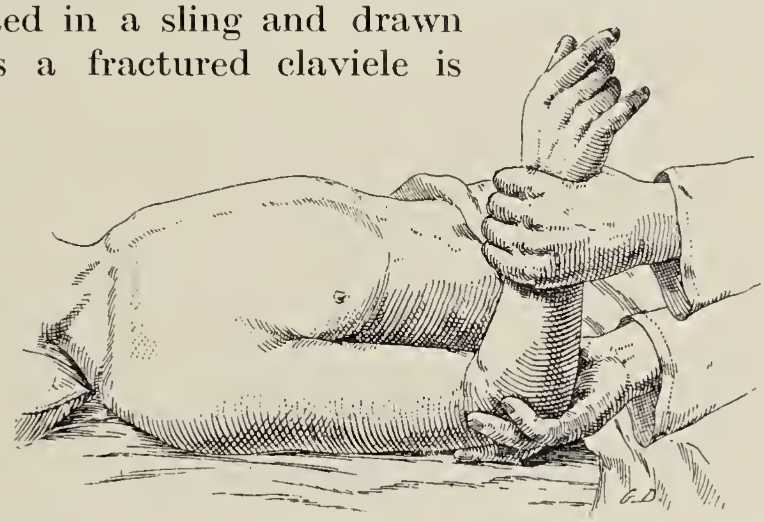


Fig. 136.—First Position in Kocher's Method for Reduction of Dislocated Humerus.

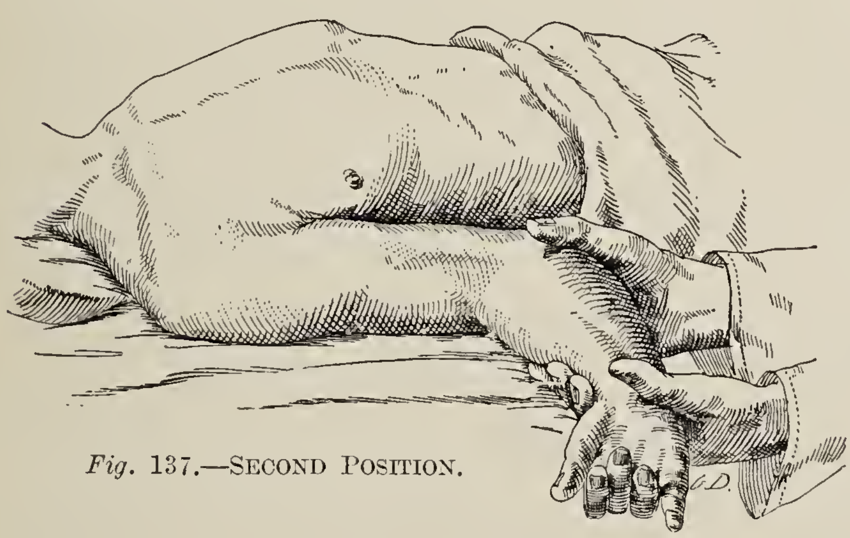


Fig. 137.—Second Position.

Dislocation at the Shoulder-joint is indicated by flattening of the shoulder, with a hollow under the acromion; the head of the humerus can be felt in an abnormal position, and the patient supports the arm, while the elbow is held away from the side. There is rigidity instead of mobility, and the hand cannot be placed on the opposite shoulder when the elbow is held to the chest.

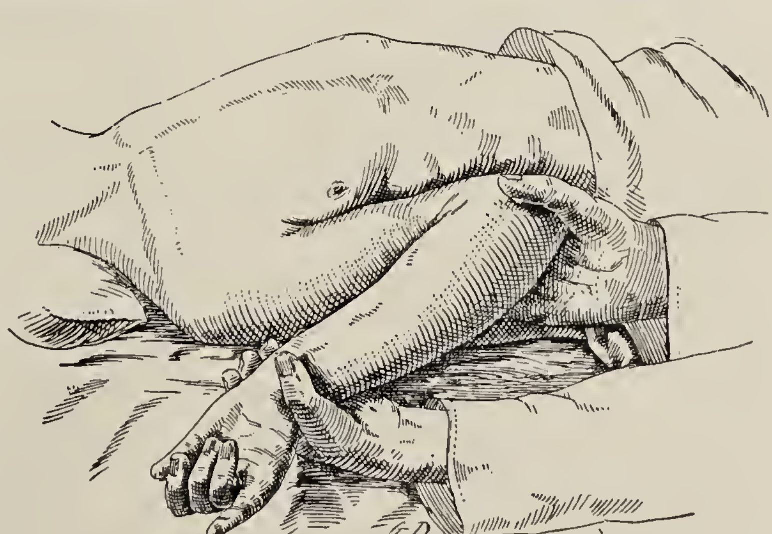


Fig. 138.—Third Position.

Several varieties of this

dislocation are known, but the most common are those in which the head of the bone has been forced out of the glenoid cavity and below it into the axilla (subglenoid), or under the coracoid process (subcoracoid).

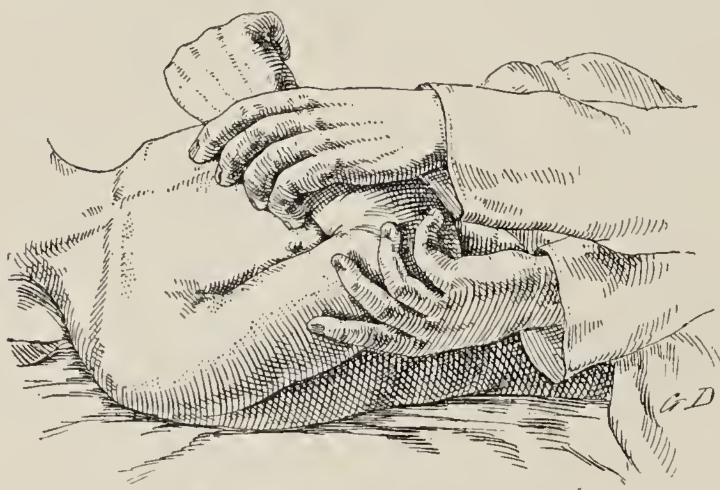


Fig. 139.—Fourth Position.

Except in muscular persons reduction can be made without an anæsthetic; but if an anæsthetic is to be given, the patient should be properly prepared for it, since death has not infrequently followed the hurried administration of an anæsthetic for the reduction of a dislocation. The reduction may be effected by extension; in the case of young people by raising the arm above the head, when, with a good pull, the bone will slip back into position.

The method known as Kocher's is a very useful one, and is practised as follows: The patient lies on a couch; the surgeon stands by his side, and places the elbow at right angles, pressing it into the side (*Fig.* 136). Taking the elbow in one hand and the wrist in the other, the arm is rotated gently outwards (*Fig.* 137), the elbow is brought forward in front of the chest (*Fig.* 138), and the hand brought over

Fig. 140.—Jones's Method of Reducing Dislocation of Shoulder.

to the opposite shoulder (*Fig.* 139). In other words, the humerus is raised, rotated out, and circumducted, the dislocation being then reduced.

Sir Robert Jones, writing on this subject, points out that " the method depends on the tiring out of the subscapularis muscle, by rotating the arm outwards with the elbow bent until the resistance of the muscle is overcome. There is no force or violence required : the procedure is not painful, and can be carried out without an anæsthetic. . . . In dealing with a powerful man it may be several minutes before the muscle ceases to resist."

" In certain cases Kocher's method may fail, and in such instances steady traction of the arm in the abducted position, accompanied by a side-to-side swing, will prove effective. The surgeon places the patient's axilla over his flexed thigh, while one assistant pulls the arm and another fixes the scapula ; gentle traction completes the operation." (*Fig.* 140.)

After-treatment.—Bandage the arm to the side for a week, and then support it in a sling, but *prevent abduction of the arm* ; allow gradual increase of the rotatory movements, and keep under supervision for a month ; passive movement should be begun during the first week with great care ; gentle massage at the earliest moment, without causing pain. A few adhesions may require breaking down (see 'Sprains,' p. 207).

In Dislocations at the Elbow-joint, both bones, or one or the other, may be displaced backwards, forwards, or laterally, the most commonly seen being that in which both bones are displaced backwards. This injury is readily recognized by the projection backwards of the olecranon, with the triceps inserted into it, and of the articular surface of the humerus in front.

The ulna, when alone dislocated, is always displaced backwards ; but the radius, when alone affected, more frequently forwards. When both bones are dislocated, or the ulna alone, reduction is effected by flexing the arm round the knee of the surgeon. The patient is seated in a chair, and the surgeon places his foot on the seat and bends the elbow round his knee (*Fig.* 141), thus levering the coronoid process of the ulna, which is the obstacle to reduction, over the end of the articular surface of the humerus.

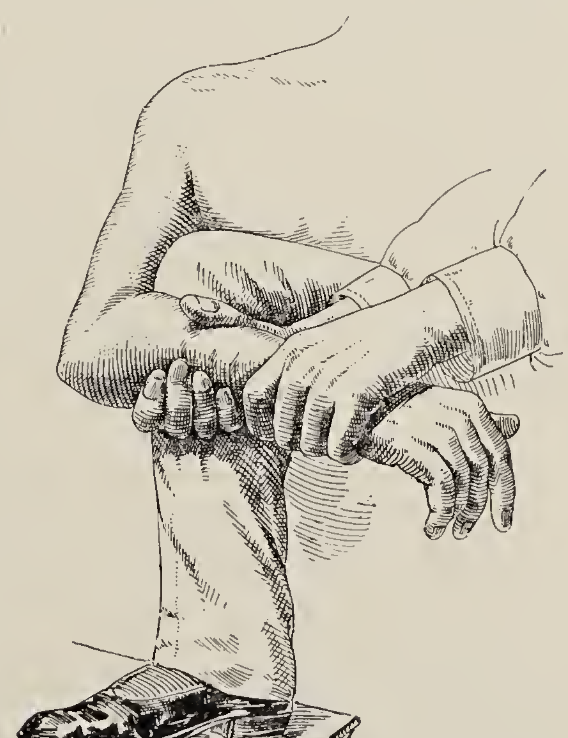


Fig. 141.—Reduction of Dislocation of the Elbow-joint.

When the radius alone is displaced, the arm should be held above

and below the elbow and straightened, and then bent at a right angle, at the same time pressing the head of the bone into place.

After reduction, the arm should be bandaged up at right angles, the hand being kept midway between pronation and supination. If the radius has been displaced, a pad should be placed over its head to retain it in position. In about a week passive movement should be commenced. When the radius alone has been displaced, it is better to fix the forearm in supination ; this should be the rule in all injuries where supination may be interfered with.

Dislocations at the Wrist seldom happen, the bones of the forearm generally breaking before the ligaments will give way. They are readily recognized by the great displacement they cause, and are reducible by forcible extension in a line with the forearm. The wrist and hand should be dorsiflexed on an appropriate splint (*Fig.* 142) and thoroughly rested ; the splint should be worn for three or four weeks.

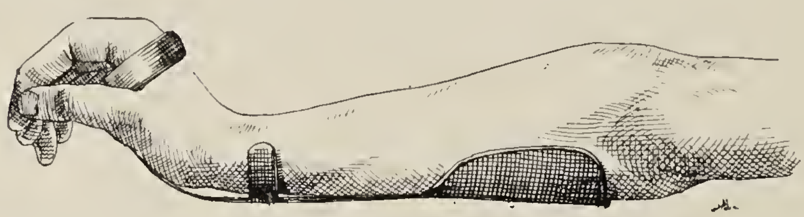
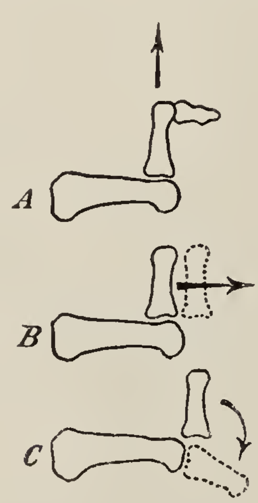


Fig. 142.—Dorsiflexion of Wrist—the Proper Position for Treatment on a Suitable Splint.

The Thumb and Phalanges may be dislocated, and the injury presents no difficulty in recognition. Reduction is sometimes a matter of some difficulty, however, and considerable force has to be exerted to draw the ends of the bones into place again. In the case of the thumb, extension is made in the direction of the axis of the displaced portion of the bone, and the bone, being thus dislodged from its false position, is brought well forward and bent down into the palm (*Fig.* 143). Extension in a straight direction will often succeed in



A.—Traction exercised in the direction of the dislocated first phalanx.

B.—The base of the phalanx drawn forward until it is level with the head of the metacarpal bone.

C.—Reduction completed by flexing the thumb into the palm.

Fig. 143.—Method of Reducing Dislocation of Thumb (Maynard Smith).

reducing the displacement. For a displaced phalanx simple extension will suffice, but the chief difficulty lies in getting a good grip of the finger.

Rest at first, followed by passive movements, is the subsequent treatment.

Dislocation of the Femur may occur in several ways, the femur passing upwards and backwards, downwards and forwards, or upwards and forwards, distinctive names being given to indicate the position the head of the bone takes.

The three commonest varieties are : (1) The *Dorsal*, in which the head passes upwards and backwards, being sometimes above and at others below the obturator internus ; (2) The *Thyroid*, the bone passing downwards on to the thyroid foramen ; (3) The *Pubic*, in which the head of the bone rests on the pubic bone or below the anterior superior spine of the pubes.

There are several other forms of dislocation, but these are rarely seen and need not detain us here.

Each of the three varieties is recognized by the abnormal position the leg assumes, and as each requires a different manipulative method for reduction, both the symptoms and mode of reduction are briefly given.

In *dorsal* dislocations, the variety most often met with, when the head of the bone has passed above the obturator internus, the thigh is flexed and internally rotated to a marked extent. The only movements of the joint possible in this dislocation are inversion, adduction, and some flexion, abduction and eversion being impossible.

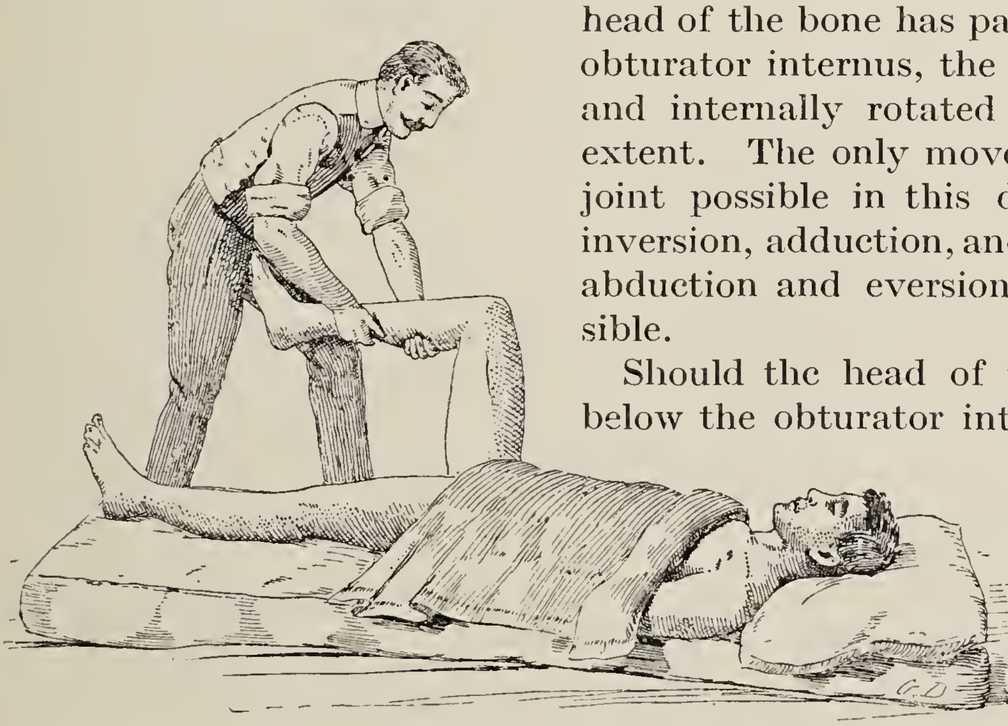


Fig. 144.—Bigelow's Method for Reduction of Dislocated Femur by Manipulation. (The pelvis is fixed by an assistant.)

Should the head of the bone pass below the obturator internus into the sciatic notch, there are flexion and adduction, but if the muscle is much torn either by the accident or subsequent manipulation, the dislocation becomes more like that just described. Diagnosis must be carefully made from fracture of the neck of the femur.

Reduction should be effected by manipulation in the following manner : The patient having been anæsthetized and laid flat on the floor, the surgeon stands on the injured side. Flexing the thigh on the abdomen with knee bent at a right angle (*Fig.* 144), he slightly adducts and rotates inwards. By this means he disengages the head from behind the socket, and with traction in the line of the femur reduction will be effected. During these and other manipulations the pelvis must be held steady by an assistant.

The same result may be obtained in a slightly different manner. The surgeon, holding the knee and ankle, flexes the thigh on the body and slightly adducts it; then abducting the leg slowly he at the same time brings the foot over the sound leg, and finally brings the leg down straight. In the words of Bigelow, the procedure is : "Lift up, bend out, roll out."

When the head of the bone is below the obturator internus the same method of reduction may be employed.

A very excellent method which can be used as an alternative to Bigelow's method, and which often succeeds when the latter fails, is performed as follows :—

The patient lies flat on a mattress, an anæsthetic is administered, and an assistant grasps the iliac crest firmly in the position of the anterior superior spines, and steadies the whole pelvis. The surgeon bends over the patient, and folds his arms beneath the popliteal space of the affected limb, which is flexed to a right angle at the hip-joint, the leg lying between the surgeon's thighs (*Fig.* 145). Strong upward traction is now made, and the head of the bone is pulled into the acetabulum.

In *thyroid* dislocations, the prominence of the trochanter is lost and the thigh abducted, the knee bent, and the foot pointed

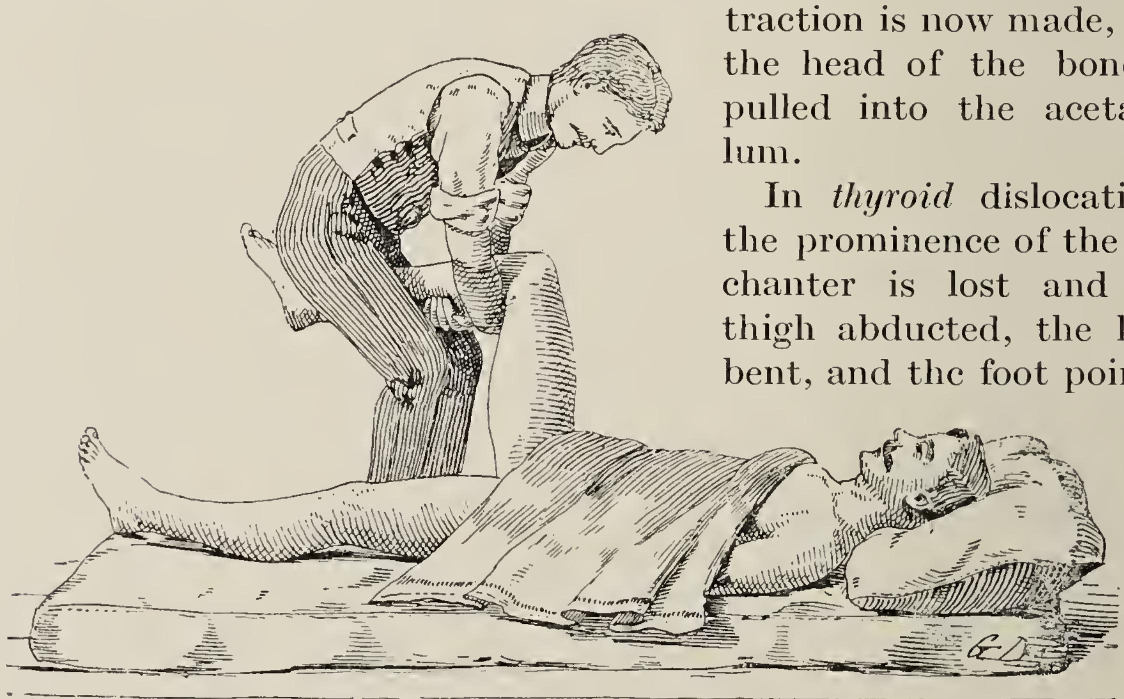


Fig. 145.—Alternative Method for Reduction of Dislocated Femur.

forwards. To reduce it, the thigh is flexed, slightly abducted, and then strongly rotated inwards, adducted, and extended.

Pubic dislocations are reduced by semiflexing the thigh, abducting and rotating inwards, and drawing the knee inwards and downwards so that the legs are parallel.

The after-treatment consists of rest in the recumbent position for some time, beginning passive movements in ten or fourteen days.

For congenital dislocations and their treatment the reader is referred to larger works.

Dislocations of the Patella are not common, but when they occur the bone is generally displaced outwards. This is readily recognized, and is reduced by flexion of the thigh at the hip-joint to relax

the extensor muscles, and by pressure on the edge of the dislocated bone.

Dislocations of the Knee are rare, owing to the strength of the ligaments of that joint, and when they do occur are often compound. They are treated by extension with the thigh semiflexed, the bone being manipulated into place.

Firm bandaging with lateral splints is required for some time afterwards, but passive movements must be commenced after two weeks.

A compound injury is a very severe one, and must be treated with the strictest aseptic precautions, but should the wounds suppurate the question of amputation will have to be considered.

Dislocations of the Ankle are generally associated with fracture of the fibula or inner malleolus, according as the dislocation is outwards or inwards (*see* 'Pott's Fracture,' p. 182).

Traction of the foot in the proper direction easily reduces the displacement, and the treatment to be followed subsequently is firm bandaging or plaster bandages.

Compound Dislocations are those in which there is a wound of the skin, either arising from the dislocated bone being forced through, or from the accident which causes the condition. They require very careful treatment. All wounds opening joints must be thoroughly washed with saline or weak antiseptic fluids, and the dirt removed with the most scrupulous care. To do this effectually an anæsthetic is advisable, and having satisfied oneself that the wound is quite clean, it should be dressed, and the dislocation reduced and carefully put up. The temperature of the patient must be watched ; any rise demands an inspection of the wound. Suppuration may mean at the worst amputation, and at the best a stiff and perhaps useless joint.

CHAPTER XIX

OF SPRAINS

SPRAINS may be defined as injuries to the soft parts, ligaments, muscles, tendons, or nerves, caused by a twist or wrench of a joint, or by an abnormal forcible movement of a joint. The term sprain will, therefore, be employed to cover a large number of common injuries, and all grades of severity may be encountered, from a slight stretching of some ligamentous structure unaccompanied by swelling, up to the most severe forms where extensive rupture of muscle and ligaments has occurred.

The following classification of sprains and their treatment has been largely taken from Sir William Bennett's article in the *British Medical Journal*, December, 1906.

1. **Sprains with Fracture.**—The introduction of the X rays has shown us that many conditions which were formerly treated as uncomplicated sprains, really are a combination of sprain and fracture. This is especially so in cases of injury to the hand and foot. The skiagram here shown (*Fig.* 146) shows the result of a sprain of the thumb sustained by a medical student during a football match, and it will be noticed that the sesamoid bone is fractured; the thumb was forcibly hyperextended, with this result. In some cases a sprain causes the tearing away of a tendon from its bony attachment, a layer of bone accompanying the tendon; in other cases the bone is fractured transversely or obliquely, this accident often occurring in the phalanges. It must therefore be clearly understood that, when possible, all cases of severe sprain should be examined with the X rays to ascertain the exact extent of damage done to the bones.

Fig. 146.—FRACTURED SESAMOID.

2. **Sprains with Effusion into Joints.**—As a result of damage to the ligaments of a joint, or from tearing and bruising of a synovial membrane, a sharp attack of traumatic synovitis may follow an injury. These cases are very important, since if not treated with great care stiffness is very likely to occur, and it must be borne in mind that, when a sprain is complicated by a synovitis, adhesions which subsequently may limit the movements of the joint will be both extra- and intra-articular.

3. **Sprains with Marked Swelling.**—These injuries are associated with rupture of muscular fibres and of blood-vessels. There are great swelling and discoloration of the skin if the sprain is superficial ; in some cases very large hæmatomata form.

4. **Sprains with Displacement of Tendons** occur usually in the neighbourhood of the ankle, shoulder, or wrist, when the fibrous sheath which maintains the tendon in position is ruptured, and the tendon itself slips out of place. These injuries are difficult to diagnose correctly until the swelling has subsided.

5. **Sprains with Injury to Nerves.**—All grades of injury may be met with, from simple bruising to complete rupture. In some cases the nerve is stretched, becomes slightly inflamed, and exquisitely tender. This is likely to occur when a nerve trunk passes over the region of a damaged joint, and as examples we may take the brachial plexus in relation to the shoulder, the external popliteal in relation to the knee, and the sciatic in relation to the hip. In mild cases the symptoms soon pass off, but in the more severe types there may be very great trouble.

In a few instances the nerves are actually ruptured. Fortunately, this accident is rare, since the nerves are sufficiently elastic to yield to a considerable amount of stretching, and it usually occurs where they are more or less fixed, as, for example, rupture of the upper roots (5, 6) of the brachial plexus in injuries and sprains of the neck, or of the circumflex nerve in some injuries to the shoulder.

In all cases of severe sprain examine the patient for signs of injury to nerves. If numbness of the limb persists for twelve hours after an injury, the nerves have probably been damaged (Bennett).

6. **Sprains with Tearing of the Attachment of a Muscle near a Joint.**—This form of sprain is very common, especially in the region of the elbow-joint, the so-called 'tennis elbow' being a strain or tear of one of the muscles arising from the common extensor origin.

Many other muscular attachments may be affected in a similar manner, such as the deltoid insertion, the subscapularis, the tendo Achillis, the adductor magnus, and so on.

Sometimes considerable violence has been the cause of this injury, and the muscle fibres may have been torn from the bone, setting up later a condition of myositis ossificans traumatica—e g., rider's bone ; but in many cases over-use has been responsible, and the patient gives no history of any injury.

In this type of case certain movements which put strain on the damaged muscle cause pain ; there is usually a point of tenderness at the attachment of the affected muscle : even some thickening can be detected.

Treatment of Sprains. — In cases *of Sprains complicated by Fracture*, the treatment adopted should allow the fracture to consolidate, and at the same time prevent the formation of adhesions.

In most instances it is advisable to place the limb on a splint, in the

best position obtainable, and to start massage the next day. How far it is justifiable to omit the splint must depend on the nature of the fracture and the opinion of the surgeon, but in most cases the use of a splint for ten to fourteen days at least is desirable.

Passive movement may be begun with the massage if there appears to be no risk of producing displacement or straining callus.

Sprains without Swelling are best treated by *immediate* massage, followed by the application of strapping or a crêpe Velpeau bandage. Indeed, many cases of slight sprain can be easily *walked off*.

Sprains with Swelling should be treated by rest during the acute stage, a suitable splint being provided, and hot or cold applications employed. Cold is apt to produce sloughing in patients whose vitality is poor, and on the whole hot compresses are more satisfactory. If preferred, evaporating lotions, spirit lotion, lead lotion, or a solution of chloride of ammonium, may be employed. As soon as the swelling has begun to subside, the part should be firmly strapped.

Some authorities recommend immediate strapping as tending to prevent the swelling from taking place (*Fig.* 147). It must be employed with great care, since pressure round a swollen limb may lead to sloughing and gangrene. The local application of iodine, vasogen ointment, or mercury in the form of Scott's dressing, is recommended in the more chronic cases.

How soon should massage and passive movements be undertaken? In the most severe cases twenty-four hours should elapse between injury and the beginning of the massage.

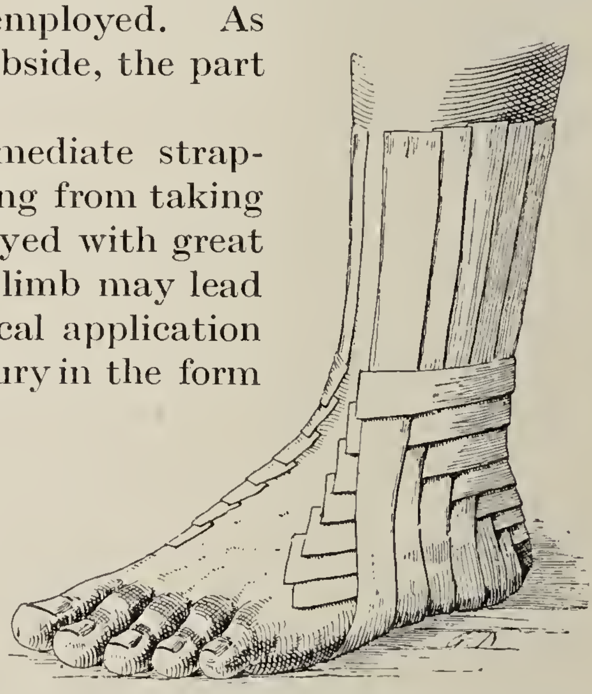


Fig. 147.—Ankle Strapped. A Gap is left in front, so that the Strapping shall not constrict the Limb.

Hæmatomata should be strapped and not opened. The blood in most cases will be absorbed, the absorption being aided by the massage. In a few cases where large collections remain, they may be opened with all aseptic precautions, the contents evacuated, and the incision closed.

The guiding principles of treatment of these cases are *pressure*, *massage*, and *movement*: passive movement at the start, and active or voluntary movement as soon as acute symptoms have subsided. The range and extent of the movements must be limited by the results they produce; in no case should they excite a return of the swelling and pain. Within a few days (five to seven), the patient should be encouraged to use the limb for ordinary movements—walking, or grasping—until the normal condition is obtained.

Sprains with Effusion into joints are treated in the same way. For an acute effusion a splint is necessary, followed by strapping, massage,

and passive movements. It is very necessary in these cases to massage the muscles around the joint. If the joint is very tense and the pain severe, the joint should be aspirated, and the excess of synovial fluid withdrawn.

Sprains with Nerve Injury are the most difficult to treat. Massage often causes the most intense pain ; but it must be employed as soon as the patient can bear it. Blisters over the course of the nerve are often of great value, as are also the use of an electric current, and douching.

Gross injury, such as rupture, will require operative treatment.

Sprains of Muscular Attachments.—If the muscular fibres are torn away from the bone, carrying a flake of the bony surface, the limb must be put into such a position as will bring the damaged surfaces into the best apposition.

For example, in severe injuries to the shoulder, the great tuberosity is sometimes torn away from the humerus. Now, the muscles attached to this piece of bone are abductors and external rotators. It is obviously quite impossible to bring this small fragment of bone down to the head of the humerus, but it is quite easy to bring the abducted and externally rotated head into close relationship, if not in contact, with the torn tuberosity. With the patient's arm abducted and his hand lying on his neck, the fragment is approximated to the rest of the bone. If the limb be fixed—preferably in plaster—in this position for a month, and then be gradually brought down, union should occur. (*See Fig.* 102.)

In the majority of cases the injury is not so serious—some muscular or tendinous fibres are torn ; but the same principles are to be applied —namely, to keep the damaged tissues as much in contact with one another and as much at rest as possible. Put the affected limb in such a position that the damaged muscle, tendon, or ligament is relaxed and placed at rest ; e.g., in a strain of the external lateral ligament of the ankle, *evert* the foot into a position of valgus, and fix it for such time as will allow of repair of the damaged tissues —about three weeks ; subsequently let the patient get about with a boot thickened on the *outer side* of the *sole* until all pain and tenderness have gone. Again, in case of strain of the insertion of the tendo Achillis, pain is caused by full dorsiflexion, which puts the damaged tendon on the stretch ; prevent this by fixing a bar on the heel of the boot, which will prevent any strain being thrown on the attachment of the tendon. It is unnecessary to go into further details—it is enough to remind readers that in strains of the tibial tubercle and other muscles the same principles are to be observed.

When the condition has become chronic through neglect, three things can be done : (1) Assure the patient that the pain will ultimately disappear ; (2) Place a firm pad of strapping several layers thick, sticky side outwards, over the tender spot ; (3) Apply the cautery, either in a punctiform manner over the affected area, or

deeply with a hot needle. This is an old-fashioned remedy, but it acts magically.

This will be a convenient place to mention a form of **Internal Derangement of the Knee,** which appears to be due to some displacement of one of the semilunar cartilages, generally the inner one. The usual history of the injury is that the patient, during some sudden rotatory movement of the body, feels an acute pain in the knee, while the joint becomes incapable of full extension, though it can be flexed, and will allow of no weight being borne on it. Often the patient falls to the ground as if he had been shot. Soon, *tenderness and signs of effusion* into the joint come on, and these are generally out of all proportion to the very slight twist which has been the cause. Sometimes these symptoms disappear as quickly as they arose, after some slight movement; sometimes they obstinately remain as a chronic synovitis. This constitutes what is known among football players, to whom the accident most frequently occurs, as 'water on the knee.'

If the joint be examined, it will be found that where the internal cartilage comes nearest to the surface (where, indeed, it is almost subcutaneous), there will be a spot of acute tenderness, and probably a little swelling. If this be found, the remedy is easy, and striking in its effect. Taking hold of the limb above the ankle with one hand (the patient lying or sitting), the knee should be strongly flexed, while the thumb of the other hand presses the cartilage inwards. Then, *without warning*, the limb should be *jerked into extension*, the pressure being kept up the while. In most cases, even at the first attempt, the cartilage will slip back into its place, and the patient will be able to extend the knee with great relief; but sometimes the manœuvre will have to be repeated two or three times.

The cause removed, the pain and effusion quickly disappear. It is wise, however, to rest the joint for a few days and to wear a woven or elastic-felt bandage, or a laced knee-cap. Unfortunately, when once this derangement has happened, it is *very apt to recur*, and there are many who do not feel themselves safe to undertake such forms of exercise as running, jumping, or dancing, lest they should be suddenly disabled. Many also learn how to put their joints right again for themselves.

Much may be done by massage, the douche, and judicious support, to brace up the relaxed ligaments, and lessen the liability to recurrence; but repeated dislocation is apt to lead to a *chronic synovitis*, and to distortion of the cartilage. This condition may call for an intra-articular operation for removing the cartilage.

The symptoms which arise when a true *loose body* (usually originating as a pedunculated growth from a fringe of the synovial membrane) gets nipped between the joint surfaces, are almost identical with those we have described, except that there is not so much limitation of extension. Such cases demand operative treatment.

Adhesions are the inevitable result of sprains of joints, tendons within their sheaths, and muscles ; they are the result of the organization of a fibrinous exudate or lymph thrown out during the process of repair. In a sense they are protective, in that nature has designed them in order to keep damaged tissues at rest. In practice, they are troublesome, since once repair has been effected, they limit the movement of the part.

Massage and passive movement may prevent their organization. But the exercise of these manœuvres often defeats the end in view by increasing the local damage, and it is often far wiser to accept the probability of adhesions being formed, than to rush to violent and exaggerated movements in the early stage of an injury.

If an injury has been severe to a joint or to the structures round, it may be assumed that some residual adhesions will require treatment. This treatment consists in 'breaking down' these fibrous bands. Now, the reader must picture a joint in which such bands occur, and also the result of forcibly rupturing them—namely, the occurrence of a certain definite trauma and bleeding. Obviously, we should endeavour to rupture these adhesions with as little disturbance as possible ; and this end is gained by obtaining the necessary range of movement in a joint by gradual stretching—extension or flexion—*once only*. Before attempting this operation of 'breaking down,' the natural range and the varieties of movement should be considered carefully.

Take the elbow : flexion and extension and supination and pronation are required. An anæsthetic is administered (gas is not sufficient). Once, and once only, full flexion, extension, supination, and pronation are obtained by gradually applied force ; this obtained, there is no need for repeated movements, which only increase the damage. The joint is wrapped up in many layers of cotton-wool and firmly bandaged, and as soon as the patient has come round an injection of morphia may be given, as these manipulations cause pain. Next day the compress is removed, the movements are repeated without an anæsthetic, and the patient is encouraged to use his joint. It may be necessary to perform these manœuvres more than once ; but nothing is gained by over-treatment.

Remember that bones near damaged joints are easily fractured. Therefore, when breaking down adhesions, always protect the bones near the joint either with the hand or with some form of splint.

SECTION IV

OF WOUNDS, ULCERS, AND BURNS

CHAPTER XX

OF THE DRESSING OF ACCIDENTAL WOUNDS

IN the present chapter we propose to consider the general principles of **Dressing Wounds,** and the ways in which they are dressed in practice.

We shall first take those which may be properly called *Cuts* or *Incised Wounds,* large or small, in which a quick healing is to be desired, and should generally be attainable, and we shall consider the rules as to their washing, closing, and draining, which are founded on the laws of antiseptic surgery.

Some of the general ways of **Dressing,** that is, of covering or protecting these wounds, will now therefore be described, while in the following chapter the methods will be considered in detail of a more scientific treatment of wounds.

In the succeeding chapters of the section the management of bruised wounds, of special forms of wounds, and of burns, abscesses, and ulcers, will be discussed.

For any wound *to heal well,* the following conditions must be fulfilled :—

1. The wound must be cleansed, and kept clean.
2. The divided tissues must be accurately readjusted and retained in position.
3. The parts must be kept at rest.
4. All effused fluids must be able to escape. The primary blood effusion *must be arrested completely,* and the wound must be covered and protected by some dressing material.

THE CLEANSING OF THE WOUND.

This will be necessary, even when it has been inflicted with a perfectly clean instrument, lest blood-clots remain in it. For ordinary cases, the thoroughness with which the washing is performed is more important than the fluid which is employed. Unless the wound be contaminated, sterile normal saline is the best for this purpose.

If there be any suspicion that septic or poisonous matter has been introduced into the incision (e.g., in a dissection wound), it should be thoroughly swabbed or syringed out with iodine 2 per cent, a 1–40

carbolic lotion, perchloride of mercury of the strength of about 1–2000, or hot peroxide of hydrogen; or one of the methods mentioned in the chapter on septic wounds (Chapter XXIII) may be employed. The process of cleansing tends of itself greatly to check the capillary oozing, and hæmorrhage from other sources must be thoroughly arrested before any attempt is made to close the wound.

It must be understood that the foregoing applies especially to the cases of incised wounds which are seen in the casualty-room practice of a hospital, or under similar conditions elsewhere. When wounds are inflicted, as in operations, by a surgeon with deliberate intention, they should be aseptic from the first, unless performed for suppurative states, and not merely either fairly clean, or of various degrees of foulness. In them no efforts should be spared to maintain this aseptic condition throughout the healing, after one of the plans described in the following chapter. Even in casualty-room practice this should also be aimed at, unless the dirt, which is more or less always found in wounds on the patients presenting themselves, cannot be removed.

It goes without saying that all foreign bodies must be removed from accidental wounds, and in view of the circumstance that ordinary mud and earth are especially dangerous on account of the occasional presence in them of the bacillus of tetanus, special care must be taken to remove every particle from the wound. If the earth has literally been ground into the wound, the best plan is to place the patient under an anæsthetic, and having washed away the more loosely adherent dirt, to scrub the wound with an ordinary nail-brush and 1–40 carbolic lotion, or irrigate it with hot peroxide of hydrogen. Further, since tetanus is likely to follow the infliction of wounds which have been contaminated with soil and earth, it is advisable to give a prophylactic injection of 10 c.c. of tetanus antitoxin into the subcutaneous tissues of the abdominal wall.

There is no question but that one of the greatest causes of failure of repair is the continuance of bleeding within a closed wound. The actual bringing together of its sides does, no doubt, often effectually check further capillary bleeding, but it should not be trusted to do so. Should there be much oozing from the cut surface, a strand of catgut or a small tube should be left in a wound for a day or two, and the edges brought together over it. This, combined with firm pressure with some elastic material, such as the prepared wools now in use, will have the desired result.

THE ADJUSTMENT AND CLOSURE OF THE WOUND.

a. **Closure of its Deeper Parts.**—With the exception of the parts which are necessarily separated by the presence of drainage tubes, the adjustment and replacement of the divided tissues must be carried out throughout the whole extent of the wound, and if possible, as perfectly in its deeper parts as on the skin surface; for upon this the

manner of healing, as well as the appearance when whole, will greatly depend. But the means at our disposal for keeping the deeper parts together after replaeing them are somewhat imperfeet. In most eases the support and pressure afforded by pads and bandages put on outside the wound are trusted to keep the sides together, and if these will suffiee, so mueh the better. But in many instanees it is neeessary to fix the parts more seeurely, either by sutures passed far below the surface (deep sutures), or by what are known as 'buried sutures,' by means of whieh periosteum may be joined to periosteum, faseia to faseia, and finally, if neeessary, skin to skin by an external stitch. These buried sutures are used espeeially in aseptie surgery, and are designed to obviate the use of deep sutures or of drainage tubes. They must be made of eatgut or fine silk, and absolutely sterile, or they will be a souree of trouble.

Deep Sutures.—If the depths of the wound have to be kept together in this way, it must be beeause there is a tendeney for the parts to separate. There will, therefore, be *tension* on the sutures, and unless some precautions are taken they will speedily eut out. All the eontrivances whieh have been devised to prevent this have for their objeet that the sutures shall pull upon an area of skin at the margin of the wound whieh is shielded in some way from the direct pressure of the wire or thread. For this purpose, the suture, whieh is passed through the wound at the depth desired, enters and emerges from the skin at a little distanee from its edge, and is then fastened to a piece of rubber tubing, or passed through a perforated ivory eylinder, or piece of sheet lead or zinc eut to the requisite size, or shaped as a stud or button.

The suture may be of silkworm gut (thick), silk soaked in iodine, or silver wire, and may be passed by any of the usual surgieal needles.

For most of the eases where deep sutures are required, the best shield for praetieal use is a piece of sheet lead. It is sold in strips, ready perforated, but is best eut out with seissors to the shape required in each instanee. A pieee may be laid along each side of the wound, from $\frac{1}{4}$ in. to $\frac{1}{2}$ in. away from its edges ; holes may then be bored in it to correspond to the number and distanee apart of the sutures. The suture having been passed through the strips, the two ends are simply twisted together, or tied, so as to elose the depths of the wound. The twists should be to one side, and lying upon the metal strip.

Instead of using one long piece of shielding metal for eaeh side of the wound, a rounded pieee like a trouser button is very eommonly eut out for eaeh suture, or pieees of lead of this form are to be had ready made with two studs on them, round whieh the suture may be twisted or tied. These are eonvenient enough, but are in no way better than, and in some respeets not so good as, the plan first deseribed.

The *removal* of deep sutures is easier than the insertion, for a pair of seissors placed between the skin and the shield on one side will be

able to cut the suture short off there, and then it can be drawn out from the other side. No rules can here be given as to the time of their removal ; this must be settled in each case at the surgeon's discretion ; but in the great majority of cases their tenure is possible only for a day or two—much less, that is, than in the case of superficial stitches. Deep sutures are very rarely employed, since buried sutures, if aseptic, have all the advantages of the deep variety. In cases of amputation of the breast, when there is great difficulty in bringing the edges of the wound together, some surgeons still employ deep sutures with leaden plates.

Needles.—What is known as Hagedorn's needle (*Fig.* 148) is now largely used, the principle of it being that the cut in the skin is made

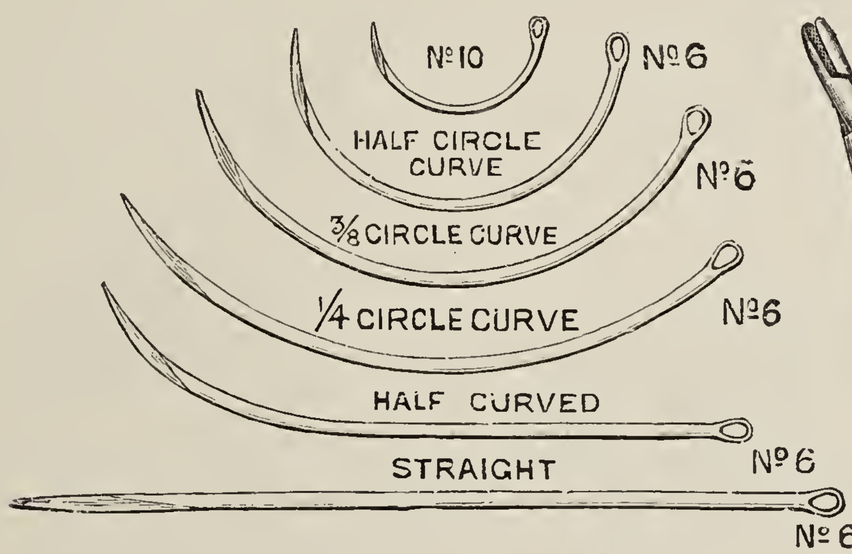


Fig. 148.—Needles for Hagedorn's Needle-holder.

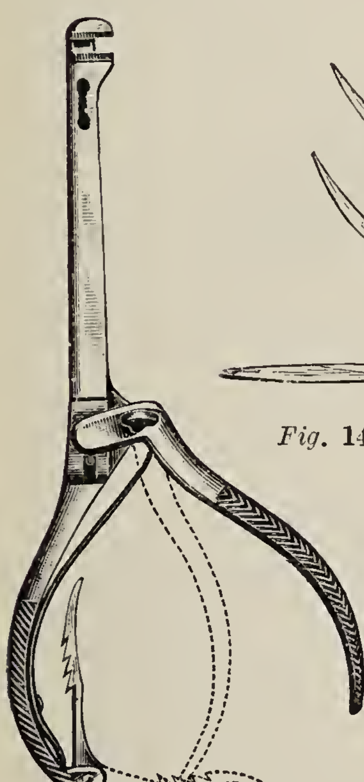


Fig. 149.—Hagedorn's Needle-holder.

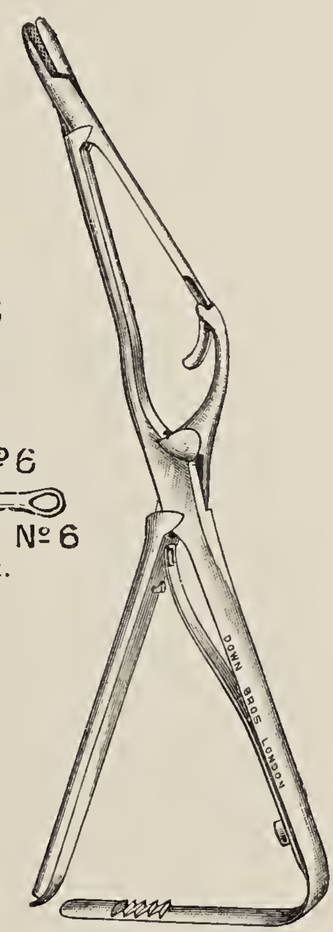


Fig. 150.—Cushing's Needle-holder for Round Needles.

in the same direction as the pull occurs, and not at right angles as is the case with other flat needles. The wound made by the needle is not then pulled open.

There are many different kinds of needle, and most surgeons have their special preference.

If short needles be used, it will be convenient, and sometimes necessary, to use some kind of holder. For needles of the ordinary kinds a pair of Spencer Wells's forceps (*see Fig.* 9, p. 13) does very well, but several forms of needle-holders are obtainable (*Figs.* 149, 150).

b. **Closure of the Lips of the Wound.**—Superficial sutures are for the accurate adjustment of the divided skin surface and of the tissues near it ; in most wounds they are the only ones required. No strict rule can be laid down as to the depth at which they should be passed, but it is often convenient to put them deep enough to arrest bleeding from vessels in the cut edges of the wound.

Suture Materials.—Silkworm gut, and occasionally horsehair, are the materials chiefly used for sutures. Catgut sutures are not quite trustworthy alone; they stretch, and they may be absorbed too soon; silkworm gut is now largely used instead, and is not open to these objections. It must be well boiled in water before use, and kept in 1–20 carbolic acid solution.

Interrupted Sutures are still very largely used, but the continuous one may often be employed, especially in intestinal surgery. In the interrupted, each point is secured separately by tying in reef knots, and the twist or knot should be at one side, and not over the line of the wound. The actual skin surfaces should, if possible, be brought together exactly, but it is better that the edges should be a little everted rather than inverted. A little inversion is often overlooked at the time of adjustment, the result being an unsightly depression.

Another way of bringing the skin edges together is by means of *Michel's clips* (*Fig.* 151), small bridges of pliable metal armed at each

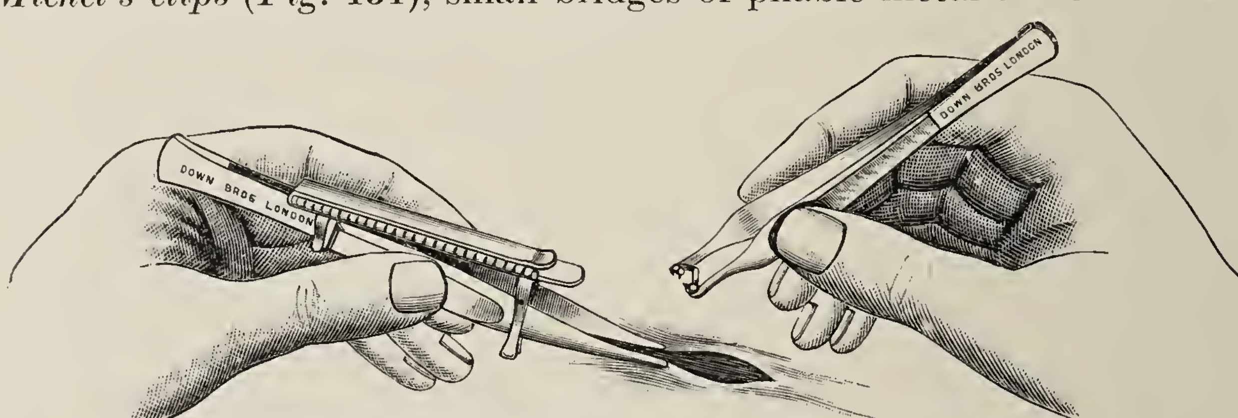


Fig. 151.—Michel's Suture Appliances.

end with a minute point. They are held over the wound and at right angles to it by means of a special pair of forceps, and are then pressed down on to its edges, while at the same time the blades of the forceps are forced together, causing the pliable bridge to bend in the middle. These clips bring the edges into accurate apposition with some slight eversion, and if removed on the fourth or fifth day leave very little scarring. They have the further advantage that, as they do not penetrate through the skin, all risk of infection spreading from the surface of the body into the wound is abolished. They are easily removed by special extraction forceps.

The Number of Sutures must be just as many as will close the wound throughout; fewer will not do, and more are needless. So long as stitches are not doing harm, there is no limit to the time they may be kept in, but as soon as there is any tension, or area of inflammation around them, they are better away.

As catgut sutures should become absorbed, they require no removal, and will come away by gentle traction on the loose end. Silk or silkworm-gut sutures require only to be snipped and removed with forceps, but this may cause pain if blood has clotted on the silk. To obviate this, the wound should be washed over with peroxide of

hydrogen, and the stitch cut flush with the skin on one side and withdrawn from the other. This little manœuvre renders the removal of stitches absolutely painless.

Adhesive Strapping may be used to relieve tension which would otherwise be borne by the sutures alone, or may be the sole means employed to close a wound. In either case, care must be taken to avoid puckering, and the best way to do this is by cutting the strips as shown in *Fig.* 58, p. 91. If the adjustment be carefully made, it is a good way of closing a wound. The widely diffused support of the plaster is extremely useful. But no wound, not even very small and clean cuts, should ever be completely closed over with strapping; a drop of pus thus shut in may work very great mischief. The strapping should always be applied over a layer of antiseptic gauze.

There only remains to be mentioned a mode of closing small wounds, especially about the face, by *collodion*; the ordinary or the flexible kind may be painted over the wound or applied upon a piece of lint, and by its contraction a close apposition may frequently be attained.

ARRANGEMENTS FOR REST.

It is not necessary to enlarge on the importance of arrangements for rest, i.e., for retaining the wound surfaces in apposition. It will be understood that a wound can hardly heal unless it be kept at rest, and also that means of securing this rest must vary with every case.

In the case of wounds of the extremities, the end desired can generally be attained by splints, interrupted if necessary, and slings and other contrivances may be brought into use, the limb being placed in the position which causes least tension on the edges of the wound. Moulded splints are especially useful in fixing the parts about a wound.

This necessity for rest must always be kept in mind in considering the firmness with which a wounded part should be bandaged.

THE DRAINAGE, COVERING, AND PROTECTION OF THE WOUND.

The means to be adopted to secure the fulfilment of these conditions include the different ways in which wounds may be drained, and the several 'dressings' that may be put on them.

There will be in all cases some fluid exudation, whether a wound has been closed before the bleeding has stopped or no, and provision must be made for its escape, except in wounds which are at once small and perfectly healthy.

The materials for drainage are, *Indiarubber Tubing*, of different sizes, or *Strips of Rubber Tissue*; but almost anything of the nature of a tube or thread, if it be in itself unirritating and aseptic, may be placed in a wound to facilitate the escape of the discharges.

As the whole object of a drain is to prevent fluid remaining within a wound, no exception can be made to the rule that all surgical cavities are to be drained *from the bottom*. The place of exit for the drain

should therefore be the most dependent part of the wound, unless, as is often advisable, a separate aperture is made for the tube alone. Often, too, it is neeessary to pass the drain right aeross the eavity, either by making it enter the wound at one end and leave it at the other—as may be done in amputations of the limbs or of the breast—or by making apertures and counter-apertures.

Coming to *Drainage Tubes* proper, glass ones have been almost entirely abandoned, except for draining the pelvis ; as fluid cannot flow upwards unless drawn by capillary attraction, a wisp of gauze should be placed inside.

But the drainage material whieh will probably be for long in most general use is *indiarubber tubing*, of whieh special kinds are made, of various sizes, and perforated at frequent intervals.

The points to be kept in mind as to the drainage of a wound by indiarubber tubing are : (1) The size of the tube ; (2) The mode of introducing it ; (3) The keeping it in its plaee ; (4) The oeeasions of its withdrawal for eleansing or shortening ; and (5) The time when it may be permanently disearded.

All drains are foreign bodies and, *ipso facto*, hurtful. The tube, therefore, must be as small as will freely carry off the discharges. No general rule ean be laid down as to the mode of its insertion. It may be put in before or after the wound is sutured, and a probe or direetor, or the speeial instrument devised by Lister, may be used. Forceps of the ordinary kind are objectionable, as they disturb the tissues.

The tube is apt to *slip out or in accidentally*, though this (whieh should not happen if the dressings are properly applied) may be prevented by passing a stiteh through the tube wall, from $\frac{1}{4}$ to $\frac{1}{2}$ an ineh from its end, and fixing it to the skin. A safety-pin may be put across the aperture of the tube, or some form of shield employed, whieh will effeetually prevent its slipping in.

For the same reason that the tube should be as small as will be efficient, it should be *removed as soon as it is safe to do so* ; and if it cannot be withdrawn altogether, it should be shortened up from day to day. But it is impossible to lay down any striet rules ; in sueh a case as an amputation of a limb or breast healing by first intention, the tube may be removed on the seeond or third day, while in some abscesses it may have to be left in for some weeks ; but in any ease it is a safe rule to follow, that every time the dressing of the wound is ehanged, the tube must be taken out and boiled, or syringed through with earbolic lotion.

When a tube has been used to drain the pelvis or some other situation where the position of the tube is unfavourable for free drainage, the exudate should be mopped out with long strips of gauze, or if very eopious it should be sucked up through a catheter attached to a glass syringe.

Most abdominal drains should be removed in twenty-four or forty-eight

hours. After that period the tube drains only its own track, being surrounded by matted omentum and coils of intestine. Cases of strictly localized abscess may require longer drainage, but as the peritoneal cavity is capable of dealing with its exudations in a very satisfactory manner, tubes may often be dispensed with earlier in abdominal than in other wounds.

All abdominal tubes should have very small lateral openings, as there is a distinct risk of omentum or intestine prolapsing through large apertures and becoming strangulated.

In cases of accidental wounds a drainage tube is usually required, but in most operations it is possible to do without one: in those, for example, where the incisions have passed through healthy structures. Here, if all bleeding be stopped before the wound be closed, and firm pressure be applied, not only by the dressings but also during the time that they are being put on, it will be found that healing will take place perfectly. There are many advantages in being able to dispense with a drainage tube, and amongst them by no means the least, both as regards disturbance of the wound and the comfort of the patient, is the greatly lessened need for changing the dressings. A tube is in itself irritating, and affords a space into which leakage of serum must, and will, take place. Its presence may also lead to the formation of a troublesome sinus which materially delays the healing.

In cases where it is not thought desirable to close the wound entirely, one angle may be left open, so that any discharge may find a ready means of escape.

SURGICAL DRESSINGS.

Although we are using the term 'the dressing of wounds' in its larger meaning, to include all the details of its management, 'surgical dressing' is a phrase generally used in a more contracted sense, to express the materials and medicaments which are put over a wound to cover and protect it, and to forward its healing. These may be conveniently divided into *dry*, *watery*, and *oily* dressings.

The medications used may have for their purpose the prevention of decomposition, or the maintenance of simple cleanliness, or some stimulation of the wound; or a cool, a warm, or a moist atmosphere may be desired, or simple greasiness of the surface. But whatever be the nature of the dressing, it must before all fulfil the indications of cleanliness, and absorption of the discharges.

While it is every day more recognized that the best way to dress a wound is to let it 'severely alone,' in general some kind of application will be required, and the nature of the dressing does in many cases affect the course of repair. Thus, granulations will often become large and flabby under fomentations, and, again, small and prone to bleed under the use of chloride of zinc. A choice, therefore, has to be exercised, but experience alone will give the power of judicious selection.

Classification.—For the purposes of description, some classification of wound dressings must be adopted, and the following may probably be found convenient. We shall first divide them into dry, watery, and oily dressings, and then arrange the drugs and materials used under each head according to whether they are chosen because they are non-irritant, anodyne, antiseptic, or stimulating.

The **Dressing by Dry Absorbent Pads** is a plan now universally adopted by surgeons. The principles of this method are dry and infrequent dressings, with immobility and pressure.

A great many different materials have been used for pads in this form of dressing, and sometimes one, sometimes another, will answer best, each individual operator having his own likes and dislikes in this as in most matters connected with surgical procedures. What is wanted is a proper firmness, combined with elasticity, so that there is a moderate restraining pressure on the wound. At the same time the material must be *sterile* and *absorbent*, to provide for infrequency of dressing. Pads of lint, of salicylic wool, boracic lint, wood-wool, carbolic or other prepared gauze, and many more, have been used. It would be impossible to say that one preparation is better than another, for all the materials now obtainable are so carefully prepared that the choice depends more on the individual surgeon than on their relative value. A wound dressed with any of these absorbent materials must have its edges, and if necessary, its deeper parts, adjusted with the appropriate sutures, and provision must be made for its drainage ; secondly, the mechanical fixation of the neighbouring parts should, if necessary, be secured by moulded splints, plaster-of-Paris bandages, or similar contrivances for immobility in the case of the limbs ; and thirdly, the parts immediately concerned in the wound must be covered and lightly but firmly pressed upon by the absorbent pads, secured by bandages or strapping.

If the discharges from a wound thus treated are only moderate in amount, there will be no necessity to change the dressings for some days, and no method gives better results in the case of large healthy wounds.

Wet Dressings.—This class of application is a very large one, and comprehends all lotions, tinctures, and hot or cold compresses ; every dressing, in short, by means of which the surface of wounds may be kept moist. In the great majority of cases, the moistening fluid is applied by soaking gauze or strips of lint in it.

Antiseptic lotions are generally used at the immediate dressing of an incision. A few layers of gauze, generally that prepared with the double cyanide, or with perchloride of mercury, or lint saturated with boric acid, are soaked in antiseptic solution and laid over the wound.

The number of *lotions* now used has been considerably reduced, the experience of the last few years having taught surgeons that carbolic acid 1–40 or 1–100, perchloride of mercury 1–2000 or 1–5000,

biniodide of mercury 1–2000 or 1–5000, and peroxide of hydrogen 5 to 10 vols., are the most suitable, but for operations on the eye, or for delicate structures, a saturated solution of boric acid or normal saline must be used.

Irrigation is a form of wet dressing which is sometimes, though rarely, used for clean wounds, especially when they are near joints, but it is much more often adopted for foul and septic conditions, more fully described elsewhere. Its great drawback is the risk to the patient of catching cold from the exposure which can hardly be avoided.

To set up an irrigation apparatus, all that is required is an arrangement by which a constant drip of water, or of some lotion, can be made to fall upon the wound. This may be done by suspending a vessel over the wound, properly fitted with a tap and indiarubber tubing, or the tube may be allowed to act as a siphon. In either case the difficulty is to get the drip to be sufficiently slow, and quite as good a plan is the simpler one of hanging one or two strips of lint from a vessel supported above the wound. The fluid is evenly distributed, drop by drop, by the strips, which act as siphons by the capillary attraction of their fibres. It will be necessary to put some pan or basin beneath the wounded part, and the bed must be kept dry with waterproofing ; but there is always some slopping, and the patient had better lie in blankets.

Plain boiled water, a solution of permanganate of potassium, or one of carbolic or boric acid, Dakin's solution, and chloramine are the fluids most frequently used for irrigation ; and although, if this treatment be continued for many days, the granulations are apt to become sodden, no dressing will more efficiently clean a wound.

Immersion of the wounded part in a bath of warm carbolic, a solution of permanganate of potassium, iodine, or boric acid, for many hours, is often also extremely beneficial.

Fomentations.—A fomentation is made by soaking a piece of lint in boiling water, and wringing it as dry as possible in a warmed towel. Some few people, laundresses especially, are able to perform this wringing with their unaided wrists, but for most it will be necessary to use a set of wringing sticks. These consist of two pieces of stick like rulers, about 2 ft. 6 in. in length, passed through the ends of a roller towel about 2 ft. 6 in. by 10 in. When the soaked lint is picked out of the boiling water, it should be allowed to drip for a few seconds, and then it must be placed in the centre of the towelling, and the whole twisted up by the leverage of the sticks until no more water comes away. This should take but a few moments. Another good way is to sew the ends of a piece of flannel together, and to pass the sticks through before the boiling water is poured on to it. It can then be lifted and wrung without loss of time, and put into a dry, warm towel.

For a simple fomentation the lint should just be applied to the skin as an application of warmth and moisture, and covered with a piece of oiled-silk slightly larger than the fomentation ; over this again a

layer of cotton-wool should be laid, and the whole fixed with a triangular bandage or a few turns of a roller.

The best material for fomentations is boric lint, or if a stronger antiseptic is required, carbolic acid 1–40 should be added to the boiling water so that an antiseptic dressing is made. Carbolic fomentations should not be applied to the fingers, as there is a risk of gangrene being produced.

But these fomentations are often used with some counter-irritant or anodyne ; thus laudanum, or the tincture of belladonna, may be sprinkled over the flannel, which may be substituted for lint if it is not to be placed on a wound; or turpentine is used more frequently still. This last forms the common turpentine stupe, so often used for lumbago. In all cases, if the fomentation is to produce its proper action, the flannel must be wrung dry out of boiling water, and if the wringing be not effectually performed it is quite likely that some scalding of the skin will take place.

Certain alcoholic *Tinctures*, generally freely diluted, were once, and are still by some, used as wet dressings. Of these, friar's balsam (tinctura benzoini co.) should be mentioned as an admirable stimulant for wounds which are slow to heal. It is applied by soaking pads or strips of lint in the tincture, and is probably the best of the preparations of aromatic gum resins.

Tincture of iodine, freely diluted, is often used as an antiseptic and stimulant application ; it makes an admirable irrigating fluid, especially for foul wounds.

Oily Dressings are rarely employed except for burns and ulcers.

Ointments of various kinds are largely employed as dressings for wounds, especially in the later stages of their healing. Some are chosen because they are non-irritant, as the unguentum simplex or unguentum acidi borici, or because they have more or less stimulant properties, as the unguentum zinci oxidi or the unguentum hydrargyri ammoniati, diluted with an equal quantity of vaseline or lard. For others the reader is referred to the text-books on therapeutics.

Vaseline is a clean and bland dressing, and serves also as a basis to which various drugs may be added, so that they can be applied as ointments. Some of these will be mentioned under the headings of the dressing of ulcers, bedsores, syphilitic sores, etc.

Lanolin, the purified cholesterin fat of sheep's wool, is largely used as a basis for ointments, on account of the power it has of penetrating the skin, and from the fact that it does not become rancid.

Speaking generally, ointments are most conveniently applied by spreading them on lint or on butter-cloth.

CHAPTER XXI

ON STERILIZATION OF INSTRUMENTS AND DRESSINGS, AND ON THE ASEPTIC PRECAUTIONS OF OPERATIVE SURGERY

EXPERIENCE has taught surgeons—or perhaps bacteriologists have—that many of the precautions once taken, such as the carbolic spray, were unnecessary, and that the destruction of bacteria, and the prevention of their access after an operation, are better effected by other means than those at first employed. This has resulted in a great simplification of methods, with considerable advantage both to the patient and surgeon.

This is not the place to enter into any detail of the wonderful effects that have followed the universal adoption of Lister's principles. Nor is it advisable to recount the methods that were employed in the early days of antiseptic or aseptic surgery. These have been so improved on that they are now quite out of date.

As some confusion may arise in the minds of beginners between the words aseptic and antiseptic, we may explain that aseptic is "applied to substances which are free from putrefaction and which cannot convey the causes of putrefaction to others" ; while antiseptic is employed to designate "substances which prevent or check putrefaction, these acting by destroying the germs upon the presence of which putrefaction depends."

A wound must be considered to have run a *perfectly aseptic course*, when there is, throughout its healing, no fever, *and no suppuration*. The object aimed at is to secure this, and however well the patient may recover, all cases must be regarded as failures in which, after antiseptic and aseptic precautions have been taken, traumatic fever, or profuse suppuration, or both, develop. It is hardly necessary to say that both aseptic and antiseptic precautions should always be taken in every case in which there is a wound of the surface.

It is obvious that when it is applied to operation wounds, the Listerian method starts under far more favourable conditions than in the case of accidental injuries ; but in both instances the same end is desired, and much the same means are taken to attain it.

These means are all of them intended to ensure absolute purity and the absence of germ elements, and they may be considered under the following heads : (1) Purity of the air ; (2) Of the instruments and dressings ; (3) Of the persons of all concerned in the operations and dressing of the wound ; (4) Of the wound itself and the parts adjoining.

Moreover, this method is concerned not only with the dressing of the wound in an absolutely cleanly fashion, but with the maintenance of it in this condition.

1. **Purity of the Air surrounding the Wound.**—Till a few years ago all operations and even many dressings were done in a cloud of vapour produced by a 'steam spray.' This has been shown to be quite unnecessary. Attempts to keep the air pure are now directed more towards filtering the air which is admitted into an operating theatre, though much air must be admitted by other means, and in private operations no such precautions can be taken.

2. **Purity of Instruments and Dressings.**—*Everything that is likely to come into contact with the wound during an operation should be boiled or sterilized by steam under pressure.* This is the keynote of successful asepsis, and any preparations of ligatures, swabs, and instruments in which such a method of sterilization is not employed, must be regarded as unsatisfactory. Although certain methods for preparing sponges have been and will be described in this book, other materials, in the preparation of which steam or boiling water has been used, are in all respects preferable.

In the case of instruments, care must be taken to see that they have been thoroughly cleaned after an operation before further use, since blood and septic matter are liable to collect between the teeth of artery forceps and other appliances, in which case mere boiling may not be sufficient to ensure absolute asepsis. After every operation the instruments should be well scrubbed with a nail-brush in running warm water, and then boiled in a solution of carbonate of soda before a final cleaning and drying.

Distilled water is much less injurious to instruments, especially knives, than ordinary tap water.

Before any operation the instruments should be boiled for fifteen to twenty minutes, and all swabs, trays, drainage tubes, gauze plugging, and towels, that may be used by the operator or his assistants, should have been thoroughly sterilized in an autoclave or other apparatus. Nothing, therefore, that has not been boiled will come into contact with the tissues, and many sources of sepsis will be eliminated.

This principle should be carried further by making use of boiled rubber gloves. Some surgeons do not advocate their use, holding that they tend to interfere with accuracy and touch, and no doubt in abdominal work this is true to some extent. But whatever view the surgeon may hold with regard to his own use of gloves, there can be no question that all assistants and nurses should wear them, since each pair of hands that is introduced into a wound or comes into contact with instruments or swabs which are to be employed is an additional source of avoidable danger.

Sterilization of dressings is usually effected by means of steam under pressure in autoclaves. These autoclaves are heavy receptacles into

which the swabs, towels, dressings, etc., are placed in perforated boxes which allow the circulation of the superheated steam. By allowing the steam to enter the autoclave under pressure, a much higher temperature is obtained, and the general custom is to allow these dressings to remain in the autoclave for an hour with a pressure of about 10 lb. and a temperature of 120° C. Such sterilization is absolutely certain, even the most resistant spores being killed by these measures. Less effective is steam at the normal atmospheric pressure—a result obtained with some of the ordinary sterilizers—and nothing short of two hours is in any way satisfactory with this apparatus. Dry sterilization is much practised abroad, and a temperature of 160° C. is easily maintained for half an hour ; the apparatus is very costly to install and difficult to manage ; it is, however, very good for instruments.

In cases of grave emergency there is often a sad hiatus in aseptic technique ; this should not occur, for it is always possible even at short notice to sterilize, at least safely, any towels and dressings required. Towels and dressings can be boiled in an ordinary fish-kettle for an hour, or if very suddenly required, towels which have been soaked for half an hour in 1–20 carbolic may be used with impunity ; it is well to remind the reader that towels from the laundry, though clean, are not sterile. In the same way, if instruments are required all of a sudden, they can be most efficiently sterilized by pouring methylated spirit over them in a metal box or bowl, and setting the spirit alight.

All instruments, especially forceps, should be counted before and after an operation, to avoid the accident of leaving them behind in the wound, and the same rule applies to gauze pads or rolls which are used in packing off the abdominal cavity during operations in this region.

Pads of Wool twisted up in gauze, or large pads of gauze, are used now in place of sponges for absorbing blood or discharges from a wound. They are very convenient, and can be sterilized with certainty. They are burnt after being once used.

Sponge Cloths, that is, open woven cotton towels, are also extensively used in the place of sponges and for placing over the mackintosh sheets, or for covering extruded viscera in abdominal operations. They can be boiled before an operation to render them aseptic.

If *Marine Sponges* are employed, they must be carefully cleaned before any use is made of them. There are many ways recommended, but perhaps the best is the following : First, as regards the selection of sponges, only those of the best quality should be used, and, as far as possible, they should be of an equal quality throughout. Having washed out the sand and small shells, which are always embedded in commercial sponges, with repeated washings of water, they should be soaked in a dilute solution of hydrochloric acid for several days, and rinsed in clean water, then in a dilute solution of carbonate of soda

to neutralize any acid which may be retained. After washing with water to remove the soda, they should be soaked in carbolic acid lotion (1–20) for some hours, squeezed as dry as possible, and gently heated to complete the drying process. The sponges should then be kept in a closed vessel ready for use.

After an operation they must be washed well with water, and afterwards with a solution of carbonate of soda, to remove the blood and fibrin, then in water again, and lastly in carbolic acid solution, and dried as before.

Another plan for cleaning sponges is to wash in a solution of hyposulphite of soda (half a pound to the gallon) to which is added 4 oz. of oxalic acid. The SO_2 generated dissolves the fibrin, bleaches the sponge, and disinfects it at the same time. The sponges are then well washed in water to remove the precipitated sulphur, and soaked in 1–20 carbolic.

3. **Purity of Persons of Dressers and Surgeons.** — Very great importance is laid on the *cleanliness of the operator's and assistant's hands*, for it is believed that septic matter is far more frequently conveyed to a wound by them than from the air or elsewhere. Most operators now make use of indiarubber gloves, which can be sterilized by boiling, and by their use one possible source of infection is eliminated. These gloves may be put on wet or dry, but in each case the hands must be scrupulously cleaned beforehand, since if this is not done, and the glove is punctured during the operation, the wound will be contaminated.

To Purify the Hands.—They should be scrubbed for ten minutes in running hot water with a nail-brush and ether soap. They should then be carefully dried, and soaked for two minutes in a solution of biniodide of mercury in spirit (1–1000); afterwards they are rinsed in an aqueous solution of the same salt (1–2000), and if gloves are used wet they are placed, after boiling, in this solution and then put on. By these means the fat and epidermal scales are removed and the skin is rendered as far as possible innocuous to the patient upon whom the operation is to be performed.

4. **Purity of the Wound and Adjacent Parts.** — The preparation of the patient's skin is considered in detail under 'Preparation for Operation' (Chapter LI); but, before the operation is begun, the preparatory dressing should be removed, the whole region washed with petrol or benzene, ether soap and water, and finally wiped over with a solution of biniodide of mercury in spirit (1–2000); or if the iodine method is employed, after removing the preparatory dressing the whole area is swabbed or sprayed with a solution of iodine in rectified spirit (2 to 7 per cent). Except for the part immediately concerned at the operation, the patient's body should be carefully covered with sterilized towels.

The details of the *Arrest of Bleeding, Drainage*, and the *Application of Sutures*, have been already described.

The wound having been made absolutely aseptic, or as near it as possible, the next point to consider is, how it is to be *dressed*—that is, *covered up*—so that the ehanges whieh it will go through from this time, until it is eompletely healed, may be performed in an absolutely healthy fashion, without fever, suppuration, or pain. To effect this, some form of antiseptic is usually employed.

Dressings have in the last few years beeome very mueh simplified, as it has been found from experience that many of the precautions formerly recommended by Lister were unneeessary.

The wound having been sutured up, the surrounding skin is wiped clean, a swab being pressed fairly firmly near the wound and swept away from it, while another is held on it to prevent any dragging on the sutures or accidental removal of the drainage tube, if one has been inserted.

Immediately over the wound is usually placed some gauze—either sterile gauze or that prepared with perehloride of mereury, known as sal alembroth, or with the double eyanide—whieh has been soaked for a few minutes in carbolie lotion ; cyanide gauze should never be used on a wound whieh has been painted with iodine, as it becomes intensely irritating. Some surgeons use borie lint. Over this are placed several layers of thin lint or gauze, and above all a large pad of some prepared wool, either Smyth's absorbent wool, iodoform wool, sal alembroth wool, or wood wool, aeeording to the faney of the surgeon. The whole mass is then bandaged firmly on, or held in plaee by broad pieees of strapping.

The steps to be taken at the future dressings are precisely the same as for the original one, and all the preeautions for cleanliness of hands, instruments, etc., must be as rigidly carried out.

It is impossible to lay down rules as to the time of re-dressing. Some cases may be left for a week, indeed until the wound is completely healed, while but few require to be dressed daily, unless there is much discharge, as in septie eases.

Any circumstance which arouses a suspieion that things are going wrong, sueh as undue pain, or a high temperature, will call for prompt re-dressing. The wound will be known to be aseptie by the absence of smell, by its edges presenting a quiet, inactive appearanee, and by the almost total absence of tenderness anywhere. The diseharge should be serous, or, in reeent cases, blood-stained, moderate in amount, and freely discharged through the tubes.

In re-dressing, the skin surface around the wound should be lightly sponged with 1–40 earbolie solution, and gentle pressure made to ascertain that there is no bagging of discharge. The drainage tube should be taken out, boiled, and replaeed if necessary. The wound should not be syringed through, as this will only separate parts which are adhering.

If at any time the wound beeomes in the least offensive, or freely suppurates, antiseptic precautions may be said to have failed, and

means must be taken to attempt to bring it to an aseptic condition. It may be necessary to take out the sutures and thoroughly cleanse the raw surface, and after taking means for the escape of any discharge of pus, the wound is dressed with absorbent wool. It is in these cases that the use of iodoform is of such value, some of the foulest surfaces becoming rapidly sweet when the powder is freely sprinkled on.

The two antiseptics which are now most used in the preparation of dressings are: (1) *Sal alembroth* (a double salt of perchloride of mercury and ammonium chloride); and (2) The *double cyanide of mercury and zinc*. Sal alembroth gauze contains 1 per cent and the wool 2 per cent, and the mercuric zinc dressings about 3 per cent of the salt; the former are coloured blue and the latter violet: the colouring matter not only renders the material easily recognizable, but also serves, in the case of the mercuric zinc, to fix the salt in the dressings. The disadvantage of the alembroth preparations is that the discharges from the wound readily dissolve the salt, and soaking in the dressings, take up an increasing amount, until the solution may become strong enough to cause vesication of the skin. In using either dressing a layer of the gauze, which has been wrung out of 1–2000 mercuric chloride or weak carbolic solution, is first applied; over this several layers of dry gauze, and finally a plentiful covering of wool.

In most hospitals the dressings are sterilized by heat the day before an operation. Special apparatus for doing this has been invented, the principle being that by the heat employed any micro-organism that may have been conveyed to the dressing is destroyed. The need of this precaution will be seen when it is mentioned that many, or even most, antiseptic dressings do not become active until they are moistened, with the result that unless the germicidal power of the antiseptic held in suspension is strong enough to destroy any germ that may be present, the discharge from the wound, with the warmth of the patient, by washing away the antiseptic, creates an ideal cultivating ground.

While these precautions are taken by many surgeons, there are some who hold that the use of antiseptic solutions is not only unnecessary but harmful. They sterilize their instruments by heat, and use no lotion but pure boiled water or sterilized saline, the theory being that by removal of all blood-clots by such an unirritating medium as water the tissues are not damaged in any way, and the natural activity of the cells—the *vis medicatrix naturæ*—is sufficient to destroy any organisms that may have strayed into the wound. This is especially so in abdominal surgery. At the same time for general work the moderate use of antiseptics is to be recommended.

CHAPTER XXII

OF THE DRESSING OF BRUISED AND PUNCTURED WOUNDS, AND OF CERTAIN SPECIAL KINDS OF WOUNDS

I.—OF THE DRESSING OF BRUISED AND PUNCTURED WOUNDS.

BRUISED Wounds.—All wounds *may*, but bruised wounds *must*, go through certain phases of inflammation ending in suppurative granulations. The accepted pathology of this process is to be found in all of the text-books, but no modern word expresses it so well as the old-fashioned phrase of the *digestion of the wound*. As soon as this is accomplished, and not till then, the wound 'cleans' and begins to heal; and if this old word were more often in our thoughts and mouths, we should more rarely see wounds with bruised and inflamed edges coerced into contact, but never into union.

The extent of this 'digestion' varies from that condition when the edges of the wound just fail to unite by first intention, but quiet down, clean, and take on a healing action within a couple of days, to that which occurs when for a considerable area round the wound the tissues have been bruised to death, and must separate as sloughs before any healing can take place.

As soon as this process is finished, whether the merest pellicle of lymph or a large slough has been thrown off, the wound presents few difficulties in the way of its dressing, and any of the plans or materials before mentioned may be used. All the precautions of drainage and cleanliness must be rigidly carried out, for though the protective power of granulation tissue against septic poisoning is very great, blood poisons may yet be absorbed through it.

It is, therefore, in their earliest stages that bruised wounds present special points in their dressing; in these injuries the *internal tension* which is sure to develop in the tissues in the immediate neighbourhood of the wound must be diminished in every possible way; moreover, as the whole process is an inflammatory one, and may be septic as well, the cleansing of the wound, and the removal of all discharges by drainage, must be carefully attended to.

A bruised or torn wound should never be tightly closed up, and this not only because the edges will not unite, but because the dragging together of tissues of doubtful vitality must still further reduce their chance of recovery. The wounded parts should be replaced and supported in a gentle fashion, by strapping or bandaging. If sutures are put in they must serve for support rather than for readjustment,

while in small wounds where there has been no tearing off of flaps of tissue it is often best to bring the edges together as well as possible, in the hope that they may have sufficient vitality to recover.

The wound must always be drained even more carefully than a clean cut, and whatever be the dressing which is applied, it must be of a kind that will keep down the swelling and tension, prevent fœtor, and hasten the separation of the sloughs, if any have formed. For these ends fomentations, frequently changed, are very useful.

When a foul wound has to be cleaned, a fomentation made of boric lint folded in several layers and put on as hot as the patient can bear it, may be employed. The surface may be sprinkled with iodoform—though many surgeons express their disapproval of the substance, it is undoubtedly useful—or with boric acid before the application of the fomentation, and the whole covered with a large pad of wool extending at least one inch round the lint on all sides. This will require changing in three or four hours.

Bruised wounds of a severe character should be treated on the same lines as the lacerated wounds considered in Chapter XXIII.

Punctured Wounds require very careful attention, as they are sometimes followed by disastrous results. This is especially the case if a large artery has been wounded or if septic matter has been carried into the tissues along the track of the puncture.

In the former case there may not be very serious bleeding at the time of the injury, and the seriousness of the case may be overlooked. Recurrent hæmorrhage follows, and the patient may lose so much blood that his life is in danger.

In the latter case, if septic matter is carried into the tissues and the external wound closes, deep-seated suppuration may take place, burrowing along the fascial planes and causing extensive destruction of the parts.

The rules that should be applied to the treatment of punctured wounds are as follows:—

1. If the wound is clean, and no important anatomical structure lies in its neighbourhood, it should be gently probed to make certain that no foreign body is present, and should then be washed out with a weak antiseptic lotion and covered with an antiseptic dressing.

2. If, owing to the position of the wound, it is probable that a large vessel has been damaged, the wound should be enlarged, with due regard to surrounding structures, and carefully explored to its depths until the damaged vessel is exposed. If the vessel is an artery it will be necessary to ligature it above and below the puncture, and to divide it. If a vein has been injured, it may be possible to close the opening with sutures or a ligature, a procedure which is scarcely applicable in the case of an artery, owing to the risk of traumatic aneurysm.

Attempts have lately been made to suture arteries, but at present it cannot be regarded generally as the safe line of treatment, unless the wound is a clean one.

If the wound has been inflicted with a septic instrument, and septic matter has been carried into it, a free incision must be made, so that the whole track can be cleaned out and drained. It is necessary in these cases, when the wound is in such parts as the thigh and buttock, to ascertain the position of the patient at the time of the infliction of the injury. The importance of this precaution will be understood when it is remembered that a stab through the thigh with the limb flexed will take a different course when the limb is extended, and the result is that careful probing in the wrong position may result in a large portion of the wound being overlooked.

A case of this kind has been noted, when the patient was stabbed in the thigh with a penknife by a boy sitting next to him in school. The wound was carefully explored, cleaned, and drained. Serious sepsis supervened, and the child died of tetanus. It was subsequently discovered that a portion of the trousers had been carried into the track and had become buried in the tissues on the opposite side of the limb. The alteration in the direction of the track owing to the change in the position of the muscles when the wound was examined in extension was unfortunately overlooked.

All punctured wounds of this character, i.e., of septic nature, should be thoroughly cleaned, drained, and allowed to granulate from the bottom, and if necessary, owing to the position of the wound, counter-drainage should be provided.

It might be possible to apply the method of excision of the wound edges, and to perform primary or secondary suture, as described in Chapter XXIII.

II.—OF CERTAIN SPECIAL WOUNDS.

The particular wounds we are now about to consider have, some of them, been mentioned before from the view-point of the arrest of bleeding, so that this complication must, for our present purpose, be excluded ; nor, again, shall we consider those wounds which are inflicted in the course of major surgical operations.

Scalp Wounds.—These are very generally bruised wounds, although in consequence of the way in which the tissues of the scalp are stretched over the calvarium, they frequently appear as incised ones, even if they be produced by the bluntest of instruments or missiles.

It used to be laid down as an inflexible rule that sutures should never be put into scalp wounds, partly because their edges so very generally fail to unite, but principally from the risks of the bagging of pent-up discharges inside the wound thus closed. It is now recognized that these risks can be avoided by the thorough use of antiseptic lotions and such powders as iodoform and boric acid, and that the tissues of the scalp are so well nourished that not only in clean cuts, but also when the parts have been split upon the skull by a blunt instrument, the edges may yet unite by first intention if they be accurately brought together and tension be carefully guarded against.

It is seldom necessary to have to allow for drainage, even in very serious scalp wounds, if the flaps of skin and the edges are carefully cleaned of all dirt with some antiseptic lotion. The surfaces may even be scrubbed with some such solution to remove dirt when it has been ground into the wound.

Wounds of the scalp have, by the use of antiseptic washes and dressings, been robbed of the greater part of their terrors ; nevertheless, they must always be watched carefully, and the whole head should be daily examined for that kind of œdema which is known as ‘ bogginess.’ The sutures must be taken out and the adhesions broken down if there be any collection of pus. Generally the thermometer will give an early warning of collecting matter.

With regard to the dressings, no wounds are better fitted for the antiseptic method, either with cyanide gauze, salicylic wool, or any of the other preparations in use. If the plan is to succeed thoroughly, the head must be shaved for some distance round the wound. If sloughing takes place (which is rare), boracic fomentations will generally be the best dressing.

A superficial necrosis of the skull may occur in connection with scalp wounds. The bone may separate as a scale of sequestrum, but more commonly the dead white patch of bare bone which is at first exposed becomes more and more encroached upon by granulations, and is eaten up by them, so to speak, almost insensibly.

Cuts of the Ear. — The special point about these wounds is that the vitality of the parts is very good, so that torn pieces, however nearly detached, should almost always be replaced. Every care should be taken to prevent future deformity. If the cartilage be torn, sutures should not be passed through it and the skin together, but cartilage must be sewn to cartilage, and skin to skin. The whole organ must be kept warm by cotton-wool.

Cut Throat. — This may be among the most serious of all wounds, even to being immediately fatal, or may be absolutely trivial. It is almost always suicidal or homicidal.

Apart from the question of hæmorrhage, the especial dangers of these wounds are, primarily, the possible injury to the air- or food-passage, or to both ; and, secondarily, the danger of pus tracking down within the compartments of the cervical fascia, involving the pericardium or pleura, or leading to septic poisoning.

In self-inflicted wounds, fortunately, owing to an apparently innate tendency of the suicide to attack his ‘ pomum Adami ’ in preference to any more vital part, the respiratory tract escapes more often than might have been expected. When it is injured, the knife or razor almost always divides the thyro-hyoid membrane, so that the rima glottidis is exposed, while the epiglottis is frequently cut away from its attachments. The cartilages of the larynx themselves may resist cutting; and from anatomical reasons it follows that any division of the trachea, or of the crico-thyroid membrane, is accompanied

by such serious injury to the great vessels that the bleeding quickly causes death. In most cases, therefore, the larynx is more often exposed than entered; but sometimes a downward direction of the cut exposes the top of the larynx alone, while in others the œsophagus may be laid open behind the opened larynx. In all these cases the proper performance of breathing and swallowing will be greatly interfered with.

If, on examination of the wound, there seems to be general laying open of the pharynx and larynx, and the chink of the glottis be freely exposed, *œdema* of the latter is practically certain to come on, and its effects had better be anticipated and combated by inserting a full-sized laryngotomy tube through the crico-thyroid space, or by performing tracheotomy. In some cases patients might be able to keep in an intubation tube. If, however, the exposure of the glottis be slight, the membrane being rather 'nicked' than divided, the patient should be anxiously watched, the steam inhalation and the instruments for tracheotomy being ready at hand, so that they can be used at once if sudden dyspnœa occur. (*See* 'Tracheotomy,' Chapter XLII.)

When the **Pharynx** is wounded, food, when swallowed, may escape by the wound, and may also set up irritation of the larynx. Both these complications are very hurtful, so that it becomes necessary to get the food past the wound in the œsophagus. For this purpose a very soft *stomach-pump tube* may be sometimes successfully introduced by the mouth, and the pump, or a length of tubing fitted with a funnel, employed. (*See* ' Use of Stomach Pump,' Chapter XXXVIII.)

But a better plan is to pass a *large soft catheter* into the pharynx through the nose. Introduced in this way, the tube will lie at the back of the food passage, and little or no spasm will be set up by its insertion. The catheter should then be connected with a tube and funnel, and in this way liquid food may safely, and indeed easily, be given.

The *Prognosis*, in the case of bad cut throat which we have been considering, is always unfavourable, for, apart from the injury itself, there is, very generally, a complete absence of any desire to get well. Nevertheless cases apparently hopeless do sometimes recover.

Whether the air- or food-passages be wounded or no, the *position of the head* is important—it should always be kept bent downwards, so that the edges of the wound may come together. Two or three patterns of bandages have been devised for this purpose.

If the patient is restless and uncontrollable, a poroplastic splint may be moulded to the head, neck, and shoulders, so as to keep the head still, and prevent him from tearing open the wound. A watcher should be provided for these cases, as they are very apt to attempt to inflict fresh damage upon themselves.

Sutures may be used in cases of clean-cut wounds which do not implicate the air-passages, but care must be taken to provide free drainage, and watch must be kept for the formation of pus, on account

of the tendency of the latter to burrow amongst the planes of the cervical fascia. Sutures should not be used when the edges of the wound are jagged and bruised, and the same rule is to be enforced after wounds involving the trachea or œsophagus. It may be absolutely necessary, however, to apply sutures to trachea or œsophagus should there be much separation of the parts after deep wounds inflicted in them. Strict antiseptic precautions should be observed in dressing all wounds.

Whether septic absorption occurs or no, a low form of *pneumonia* is very apt to develop, and is very often fatal. A stimulating treatment generally, with alcohol, will be required as a rule.

Wounds of the Buttocks.—A very awkward wound is sometimes inflicted upon the buttocks by the breaking of a chamber utensil whilst it is sat upon. This usually happens to heavy women. Such an injury, or indeed any wound of that part, is very apt to take on unhealthy action, as wounds in loose fat will do anywhere in the body; an attempt should be made to get healing by first intention, but care must be taken that the discharges are allowed to have a very free exit if this is not obtained.

Wounds into Joint Cavities.—Any wound by which the interior of a joint is exposed is a very serious occurrence, and even when the injury at the outset may seem to be only the most trivial cut, it may well happen that in the end there will result destruction of the joint, or loss of the limb, or it may be of the life. As a matter of fact it is often the trivial cuts which are the most dangerous, from the fact that they are considered trivial.

Wounds into joints may be divided practically into two classes. Under the first heading fall those cases in which the wound is a small one, or the injury unimportant in itself, being serious only because a joint is entered. In the second class come all the cases of wounds with disorganization of the joint structures, laceration of the capsule, free exposure of the cavity, rupture of the ligaments, etc.

Simple Wounds of Joints, i.e., where the joint is just opened and no more, by an incised wound.—The first and very important point to bear in mind with regard to these injuries is that in cases where there is any doubt as to whether the joint has really been opened, under no circumstances should any attempt be made to decide the question by probing, or in any other way. More mischief has often been done by an unnecessary use of a probe than by the instrument which inflicted the wound in the first place, and the only safe rule to follow is that in cases of doubt the joint must be supposed to have been opened, and be treated accordingly.

If the wound be just a *simple puncture*, in which the fact of the joint being opened has been proved by the escape of a few drops of synovia, the skin should be cleansed and an antiseptic dressing applied, the limb should be put on a splint, and if the knee or ankle, it should be swung from a cradle. An ice-bag may be applied.

If, however, the wound has distinctly *opened the joint*, a decision will have to be arrived at as to whether it will be best to further open the joint and wash it out, or simply to dress it with some antiseptic dressing. The procedure must depend very much on the nature and extent of the damage. For instance, if a small wound is made with a dirty knife, or road dirt has been ground into the joint, there is no doubt that a free excision of the wound and thorough washing out of the joint is the only method that will prevent extensive injury and possibly danger to life.

On the other hand, if the injury is made with a clean instrument, it would be bad surgery further to open the joint or subject the patient to the risk of a stiff joint.

The safe rule to follow is this. Unless there is good reason to believe that the wound has been inflicted by a septic instrument, adopt expectant treatment. Clean, and shave if necessary, the skin around the wound, and apply an antiseptic dressing. Watch carefully for signs of infection, such as a considerable rise of temperature, effusion, and pain ; if these appear, it will probably be necessary to take some active surgical measures. It is, however, not uncommon for a smart attack of synovitis to follow such an injury without suppuration taking place, and the greatest care and discrimination must be exercised as to whether the joint should or should not be opened.

There is no question but that all wounds in which *the joint can in any sense be said to be exposed* or to have its investing or lining structures seriously injured, should be treated with strict antiseptic precautions. The joint must be thoroughly syringed out with saline ; provision must be made for the thorough drainage of the joint cavity, if necessary by counter-puncture or incision. In fact, all the details of the dressing described in Chapter XX must be observed, while of course splinting and swinging are as necessary now as ever.

If the antiseptic precautions fail of their object, or if they have not been adopted, *acute suppurative arthritis* may follow, with the result that the joint is seriously damaged or destroyed.

We must not here discuss the surgery of traumatic arthritis ; but we hope that enough has been said to impress upon the reader the extreme seriousness of *all* wounds which even by the smallest aperture communicate with a joint.

Wounds of Tendons.—Tendons, especially those of the muscles of the hand or foot, are frequently divided in wounds of the extremities, and the manner in which they will re-unite will depend greatly upon their immediate treatment.

The cut ends of the tendons should be drawn out of their sheaths and stitched together by three or four silk sutures passed at right angles to the tendinous fibres, the ends being then cut short. The tendon having been joined, the sheath should then, if possible, be closed with a few points of the finest catgut suture, and the rest of the wound adjusted and drained in the usual fashion. The limb,

after dressing, must be placed on a splint in the position which causes least strain on the divided tendons. A flexible tin splint, which can easily be bent to the proper shape, will be found most useful.

Inasmuch as the great risk attending these wounds is the diffuse inflammation which is apt to attack the sheaths of tendons, and which is of a septic nature, it will be seen at once that the strictest antiseptic methods must be followed. With attention to drainage, and perfect rest on a proper splint, these cases will often do very well with dry absorbent dressings. Even if it is not possible to get the ends of the tendons quite together, they will probably join eventually by the formation of an intervening band of firm fibrous tissue, if no acute inflammation disturbs the healing process.

Wounds of Nerves.—These injuries are often overlooked, because care is not taken to test for anæsthesia or loss of motor power before an anæsthetic is given. In all wounds where there is any probability of a nerve having been damaged, careful examination of the various nerves must be made.

If a nerve has been merely contused or partially divided, no immediate treatment is necessary beyond that required for the wound generally. Afterwards return of function must be encouraged by massage and electricity, and if this fails it may be advisable to cut down and free the nerve from a surrounding belt of inflammatory tissue.

When the nerve has been completely divided, the cut ends are to be sought for, carefully trimmed with a sharp knife if lacerated, and sutured in accurate apposition with fine catgut sutures. The sheath may be sutured separately.

If this be done soon after the injury, repair of structure and function will very probably take place, for nervous tissue resists the effects of injury almost better than any other. It is well known how nerve trunks will recover their functional activity when re-united, even when the ends have been lying apart for weeks or months. The great enemy to repair is, of course, suppuration. If the wound is suppurating when the nerve injury is first detected, no effort should be made to suture the nerve until the wound has been soundly healed for four to eight weeks, or longer.

The most important details in the after-treatment are careful splinting, so as to prevent the stretching of the paralysed muscles, and the constant use of electricity.

In injuries of the musculospiral nerve, for example, the hand should be supported on a cock-up splint, so as to prevent 'wrist drop.' Similarly in other cases, the tendency to stretching must be counteracted, and the paralysed muscles should be regularly exercised with the battery, so as to prevent their becoming useless.

III.—BRUISES.

Whenever capillaries or veins are ruptured in or beneath the skin, some variety of *bruise* is produced. Under this head fall two chief

kinds of injuries: in the first there is a general infiltration of the tissues; in the second there is a bag of blood; and speaking generally, in the one the capillaries and in the other a vein of some size have been ruptured. In either case the great point to keep in mind is that the effused blood should be *left alone*, except under one or two quite exceptional conditions.

For the common bruise, or infiltration of blood, in the vast majority of cases no special treatment is required. It is very doubtful if any external application can appreciably affect the re-absorption of the effusion, or the course of the discoloration, but it is probable that local cold and astringent dressings may be useful, if applied early, in limiting the extent of the primary escape of blood. The astringent action of strong liq. plumbi subacet. is very effective, and the actions of cold and astringents may be combined.

A still better line of treatment is that by firm, even compression, but only when it can be applied in time to prevent the infiltration of the tissues taking place. A wet bandage, smoothly applied, or a Martin's indiarubber roller, may in such cases absolutely prevent the development of an ecchymosis.

This moderate pressure can never be hurtful, but it must be remembered that the vitality is greatly lowered in bruised tissues, so that all tight constriction or unyielding compression, as that of a circular piece of strapping or the corner of a splint, must be avoided, lest an ulcer, which would certainly be slow to heal, should be caused.

Severe bruises will often be associated with great swelling and tension of the parts. These must be met by position and bandaging; in *extreme cases*, when the vitality of the surrounding area of skin is seriously threatened, the surgeon should relieve this tension by operative measures. The conditions are just the reverse of those present in inflammation, and an extraordinary degree of stretching will be now borne by the tissues without their giving way or sloughing. If it becomes necessary to incise an ecchymosed area, small and numerous punctures should be made, and antiseptic precautions adopted.

When a fairly large vein is ruptured beneath the skin, a *Hæmatoma*, or bag of blood, is the result, and much of what has just been said will apply accurately to its management. The fluctuating swellings thus caused are sometimes very large. Thus, the rupture of the saphena vein may cause an effusion which will give a wave of fluctuation from the knee to the crest of the ilium, and, generally speaking, the blood thus poured out does not coagulate in the same way as if it had escaped from the body. Rest, position, local cold, and especially carefully regulated pressure, as with indiarubber or other bandages, will in almost all cases effect their re-absorption. They do, however, sometimes suppurate, and sometimes they remain with the blood unabsorbed for an indefinite time. In the first case the tumour must be opened and drained like any other abscess; in the second, when patience has fairly been exhausted, and it is plain that absorption

is not going to take place, the fluid must be removed. Sometimes aspiration, or the use of a small trocar and cannula, will be sufficient to empty the sac, but in most cases it will have to be laid more freely open, and the contents turned out ; the operation should be performed aseptically, and the cavity thoroughly washed out, while pressure should always be put upon its walls to prevent a fresh filling up; it will not be necessary to drain, and the incision may be sutured up completely.

Lastly, as in the case of a diffused ecchymosis, sometimes, but very rarely, the tension on the tissues bounding a hæmatoma may be so great that it must be relieved by incision.

Special Bruises.—First among these may be mentioned *Hæmatoma of the Scalp*, generally occurring in newly-born infants as one of the accidents of labour, but also as a complication of fractures and other injuries to the head. Unless actual death of the skull bone takes place, which is very rare, the blood is invariably re-absorbed, and incision is never required. The peculiarly deceptive feeling simulating depressed fracture is described under 'Injuries of the Scalp.'

Subconjunctival Ecchymosis is sometimes of importance as a diagnostic sign in suspected fracture of the anterior fossa of the base of the skull, but it commonly occurs almost spontaneously, as during a paroxysm of whooping-cough. It should always be left alone, as it is never in itself a matter of importance, and is generally soon absorbed.

So, too, with the ordinary *Black Eye*, when the extravasation has once taken place, no application will affect the rainbow-like hues of the discoloration, or make them disappear quicker than in their own good time. But the early application of cold, as by an ice-bag or an evaporating lotion, or of astringents, and especially of the acetate of lead, may do a good deal to limit the actual escape of blood and serum.

Hæmatocele should also be mentioned as being an extravasation of blood into a natural cavity, usually the cavity of the tunica vaginalis testis. Whether it occurs spontaneously or in consequence of a blow, its treatment does not differ from that of other hæmatomata. Elevation of the scrotum, cold, and carefully managed compression (strapping the testicle, *see* p. 92), will powerfully aid the absorption of the effused blood, and if these measures fail, the cavity of the tunica vaginalis must be opened. If there be reason to believe that its contents are chiefly fluid, a hydrocele trocar may be used (*see* treatment of 'Hydrocele') ; but if the clotted blood cannot thus be removed, the cavity must be laid open and the case treated as a hydrocele.

IV.—FROSTBITE.

A few cases of this injury occur in this country whenever it is visited by severe weather, generally in ill-fed, ill-clad people, whose circulation is enfeebled by privation or organic disease, and although

it is in no sense a bruise, it may here be shortly considered. The main point to recollect about this form of gangrene is, that the tissue dies, not when it is frozen, but when it thaws, in consequence of the intense capillary congestion then set up. In countries where such an accident is common this is well known, and when any part, as the nose or tip of the ear, becomes dead-white and loses its sensibility, the custom is to rub it for a long time, but not too vigorously, with handfuls of snow. Following the same principle, great care must be taken not to thaw the frozen part too quickly. The patient should be kept in a cold room, and bathed first with cold water, and then gently rubbed with the hand till circulation begins to be restored, when there will be much throbbing and feeling of heat, and the extent of the mischief will be disclosed. The parts should be kept warm, and when the period of reaction is over, fomentations are of great service in assisting the separation of the sloughs. Gentle massage is also of service. These patients suffer great pain, so anodynes in the shape of aspirin or forms of opium must be given.

In the cases occurring in the recent war, all observers were struck by the powers of recovery possessed by the tissues ; toes that appeared at first shrivelled and black, in a few days might recover completely. *Do not be in a hurry to amputate.*

Sometimes a frostbite is produced by the prolonged application of the ether spray, especially if the parts frozen are already in a state of inflammation ; and even an ice-bag, if left on for too long, may produce sloughing. Thus an ice-bag, left on a hernia for a night, has caused extensive destruction by the morning.

CHAPTER XXIII

ON BULLET AND SHELL WOUNDS, AND THE EXTRACTION OF FOREIGN BODIES; TOGETHER WITH A GENERAL ACCOUNT OF THE TREATMENT OF SEPTIC WOUNDS AND INFECTED FRACTURES

THIS chapter comprises the methods available for the control of severe sepsis, and the treatment of lacerated infected wounds caused either in war or in civil life.

THE CONTROL OF SEPSIS.

The majority of the wounds inflicted by shells, bombs, and other missiles—with the exception of occasional bullet wounds—are profoundly septic. This sepsis, dependent for its production upon contamination of the wound with soil rich in micro-organisms, forms one of the most serious problems which surgeons have to face. The ordinary antiseptic methods are often found inadequate, either owing to the virulence of the sepsis, or to the difficulty of applying these antiseptics in anything like sufficient quantity; or again, perhaps, owing to the unsuitable character of the latter. Scientific research was stimulated, and certain definite modes of treatment have been evolved.

1. **Wright's Method.**—This deserves pride of place owing to the date of its inception, if not from its merit. It consists in the elimination of all so-called antiseptic treatment, and in the free irrigation of the wounds with normal saline or with hypertonic saline solution. For the latter solution—5 per cent in strength of sodium chloride, to which is added 1 per cent of citrate of soda solution—there is claimed a lymphagogic action which floods the wound with protective and cleansing serum.

While theoretically fascinating, the method is practically disappointing; and although it has had the advantage of an extended trial, it is inferior to some of the more recent discoveries.

2. **Salt Packs.**—This method, introduced by Gray, of Aberdeen, and modified by Hull, consists in packing into the depths of the wound tablets of salt surrounded by gauze; these packs are left unchanged for several days, and when removed the wound is found to be clean and granulating. Whether this virtue of the salt pack is to be found in its lymphagogic action, or in the pickling or antiseptic properties

of strong NaCl, is a matter still under discussion. It is unsuitable for the worst cases of sepsis, with shock and exhaustion.

3. **Carrel-Dakin Method.**—Generally speaking, the best results have been obtained by this method: sepsis has been controlled or aborted, secondary hæmorrhage has been avoided, and wounds have been made fit for suture in ten to twenty days.

In this, as indeed in every method here discussed, a thorough cleansing or toilet of the wound is a necessary preliminary. All foreign material or damaged tissue should be removed as far as is possible, hæmorrhage should be checked, and the skin surrounding the wounds should be thoroughly cleaned with petrol or some other penetrating agent. The wound should be systematically explored, as recommended in the treatment of compound fracture. Carrel's method, however, allows deviation from the general rules applicable for drainage, in that counter-drains are not required.

Into the wound thus prepared a suitable number of Carrel's tubes, with gauze loosely between them, are introduced. These tubes (*see Fig.* 152) are fine rubber tubes closed at the distal ends, and having minute perforations extending for an inch or two up towards the proximal end, which is connected by means of a glass piece to a reservoir containing Dakin's solution.

The modified form of Dakin's solution now employed is that of Daufresne. It is a solution of sodium hypochlorite, and must be free from caustic alkali. It should contain 0·45 to 0·50 per cent of hyperchlorite; under 0·45 per cent it is not active enough, and above 0·50 per cent it is irritating.

" Preparation of the Solution.—With chloride of lime (bleaching powder) having 25 per cent of active chlorine, the quantities of necessary substances to prepare 10 litres of solution are the following:

" 200 grms. chloride of lime (bleaching powder) (25 per cent active chlorine).

" 100 grms. sodium carbonate *dry* (soda of Solway).

" 80 grms. sodium bicarbonate *dry*.

" Put into a 12 litre flask the 200 grms. of chloride of lime and 5 litres of ordinary water, shake vigorously for a few minutes and leave in contact for six to twelve hours, one night for example. (Shake until dissolved—at least until the big pieces are dissolved. Not all the pieces will dissolve; large pieces float, notice only floating pieces.)

" At the same time, dissolve in 5 litres of ordinary cold water the carbonate and bicarbonate of soda.

" After leaving from six to twelve hours, pour the salt solution in the flask containing the macerated chloride of lime, shake vigorously for a few minutes and leave to allow the calcium carbonate to be precipitated. In about one-half hour siphon the liquid and filter with a double paper to obtain a good, clear liquid, which should always be kept in a dark place.

" *Titration of Chloride of Lime* (*bleaching powder*).—Because of the

variation of the products now obtained in the market, it is necessary to determine the quantity of active chlorine contained in the chloride of lime which is to be used. This must be done in order to employ an exact calculated quantity according to its concentration.

"The test is made in the following manner : Take from different parts of the jar a small quantity of bleaching powder, to have a medium sample, weigh 20 grms. of it, mix as well as possible in a litre of tap water, and leave in contact a few hours. Measure 10 c.c. of the clear fluid and add 20 c.c. of a 10 per cent solution of potassium iodide, 2 c.c. of acetic acid, or, to free all hydrochloric acid, put drop by drop into the mixture a decinormal solution of sodium hyposulphite (2·48 per cent) until decoloration. The number n of c.c. of hyposulphite employed, multiplied by 1775, will give the weight N of active chlorine contained in 100 grms. of chloride of lime.

"The test must be made every time a new product is received. When the result obtained differs more or less than 25 per cent, it will be necessary to reduce or enlarge the proportion of the three products contained in the preparation. This can easily be obtained by multiplying each of the three numbers, 200, 100, 80, by the factor $25N$, in which N represents the weight of the active chlorine per cent of chloride of lime.

"*Titration of Dakin Solution.*—Measure 10 c.c. of the solution, add 20 c.c. of potassium iodide 1-10, 2 c.c. of acetic acid, and drop by drop a decinormal solution of sodium hyposulphite until decoloration. The number of c.c. used multiplied by 0·03725 will give the weight of hypochlorite of soda contained in 100 c.c. of the solution.

"Never heat the solution, and if in case of urgency one is obliged to resort to trituration of chloride of lime in a mortar, only employ water, never salt solution.

"*Test of the Alkalinity of Dakin Solution.*—To differentiate easily the solution obtained by this process from the commercial hypochlorites, pour into a glass about 20 c.c. of the solution, and drop on the surface of liquid a few cgrams. of phenolphthalein *in powder.*

"The correct solution does not give any coloration, while Lebarraque's solution and *eau de Javel* will give an intense red colour, which shows in the last two solutions existence of free caustic alkali.

"The stock solution should be kept in blue or brown coloured bottles, well corked.

"*Difficulties in making Dakin Solution.*—On account of the unstableness of bleaching lime, which varies in its chlorine content from 15 to 37 per cent active chlorine, some difficulty has been encountered in making the solution.

Much of the sodium bicarbonate used to-day is composed largely of sodium carbonate : this is one of the causes for the difficulty of neutralizing the solution. If the solution is alkaline or caustic, it will burn the skin and irritate the tissues. *It must be neutralized with sodium bicarbonate, and should be frequently and thoroughly tested on account of its unstableness and tendency to become caustic.*"

There is a difference between the solution of Dakin as originally made and the hypochlorite solution, technique of Daufresne. Dakin's original solution contained 0·5 to 0·6 per cent sodium hypochlorite. The solution modified by Daufresne does not contain boric acid, but contains between 0·45 and 0·50 per cent hypochlorite ; it is very important that the solution should not be over 0·50 per cent—if it is, it will be too caustic, and if below 0·45 per cent, too weak.

Many of the so-called Dakin solutions are not prepared in accordance with the formula of the name they bear, and as a result the solution has been condemned where some other solution has been used in the name of Dakin.

When the wound has been treated as advised above, and the tubes have been introduced, a test injection is made to ascertain how much fluid is required to fill the wound, and a final dressing of gauze soaked in Dakin's solution is applied. Turkey towelling is an excellent application over the gauze.

" Description of Apparatus and Method of Application of the Tubes.—To carry out accurately the Carrel technique, it is absolutely necessary to employ the special apparatus which has been designed for this purpose. Many of the failures have been due to the incompleteness of the standard equipment and an attempt to modify it. (*Fig.* 152.)

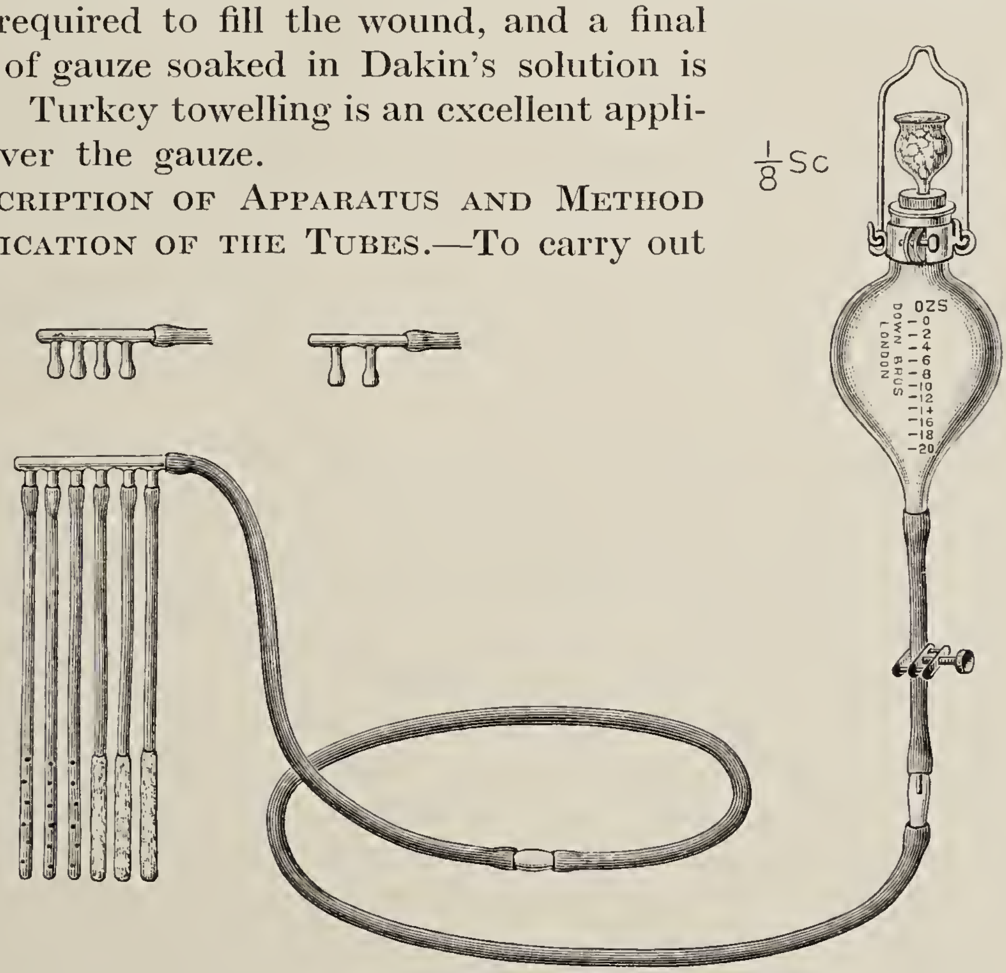


Fig. 152.—Carrel's Apparatus for administering Dakin's Solution.

" The vessel containing the solution somewhat resembles a Kelly infusion bottle in shape, being graduated in cubic centimetres, so that the amount of solution injected in the wound can be accurately measured. The neck of the container is closed with a rubber cork through which a glass thistle is passed. The bulbous portion of the thistle is filled with sterile cotton ; the thistle serves the double

purpose of preventing loss of chlorine from the solution and allowing sufficient atmospheric pressure to permit a free flow of the solution from the container into the tube. The projection at the bottom of the container, to which the tube is fastened which carries the solution into the distributor, is a continuation of the bottom of the container itself, and allows complete drainage from the bottle. Rubber tubing, 1 cm. outside diameter, carries the solution from the container to the distributor. A glass drip, the lumen of which is 6 mm. in diameter, is inserted in the main tube between the outlet of the container and the distributor. This drip indicates the rate and amount of solution flowing from the container. The glass distributors are made so that the inlet can easily be slipped into the rubber tubing from the container. These distributors are made in multiples, having from one to five outlets to which the Carrel tubes are attached. The outlets from the distributors should be made so as to allow the easy attachment of the Carrel tubes. The Carrel rubber tubes are approximately 15 to 25 cm. long, having a diameter of 5 mm., the inside lumen of which is 3 mm., giving 1 mm. wall for the tube. They should be made of pure rubber, so that the end of the tube can easily be tied off with either Pagenstecher linen or strong silk. Rubber tubing containing fabric or catheters will not suffice, because of the difficulty in closing the end and the destructive action of the hypochlorite on the fabric.

"Beginning from the distal end, a series of small holes, approximately ½ mm. in diameter, is pierced at intervals of ½ cm.; six, eight, ten, or twelve perforations are usually sufficient, and are made with a specially designed punch (similar to a leather punch). Both sides of the tube are pierced with one punch; the tube is then turned on its axis to a right angle and the process alternately repeated, thus staggering the perforations. Extreme care must be exercised to remove the rubber plugs made by the punch, so that there will be no obstruction to the flow of solution. These plugs can readily be removed by stretching the rubber. The number of tubes to be used must be decided by the size and depth of the wound. They should be inserted so that all parts of the wound are constantly bathed with the solution. To prevent the tubes from bunching in the wound, strips of gauze are loosely placed between them. The gauze serves the double purpose of keeping the tubes *in situ* and retaining the solution. Gauze should never be packed tightly in the wound. A gauze compress is gently placed over the tubes, and the dressing completed by covering with Turkish towelling. The dressing is fixed with a bandage, care being taken not to constrict the tubes, but fixing them to prevent displacement.

"The bleaching properties of the hypochlorite rapidly destroy the cotton fabrics. In the severe cases, a large pad of non-absorbent cotton which completely envelops the extremity can be used. Non-absorbent cotton is used to prevent the taking up of the Dakin solution

from the wound. This dressing should be, approximately, 3 cm. in thickness, and is made in various sizes and shapes.

"For superficial wounds, the Carrel tubes are covered with Turkish towelling, extending from the distal end to a point just beyond the proximal perforation. These tubes remain in position without slipping over the tissues, and keep the wound areas sufficiently bathed. Strips of gauze should then be placed between the Turkish towelling tubes; this tends to keep them in position and also retains the solution.

"The graduated container should be elevated not more than three feet above the patient. A stopcock is placed distal to the outlet of the container. The solution should be allowed to flow into the wound by releasing the stopcock, allowing just sufficient solution to enter the wound to fill it and not overflow. The wounds are 'laked' or 'puddled' with the solution. Where pain is experienced, the container should be lowered; the pain is due either to pressure or the causticity of the solution.

"Emphasis must be laid upon the fact that the most effective method is the intermittent installation every two hours, day and night, and not constant irrigation. The amount of solution to be injected can be prescribed by the surgeon in charge. However, the attending nurses soon learn by experience just how much solution is necessary.

"*The Re-dressing.*—The wounds should be re-dressed daily; every aseptic precaution should be scrupulously exercised. The hands should at no time come in contact with the wound; the entire dressing being completed with either tissue forceps or hæmostats. Re-infection of a sterilized wound can easily be caused by errors of technique. The skin surrounding the wound should be thoroughly cleansed with ether, which dissolves the vaseline from the skin. This is followed by a sponging of the skin with cotton, using a neutral sodium oleate solution, which is a very satisfactory cleansing solution; it is neutral and non-irritating. The wound is then gently sponged with sodium oleate solution, this being followed by a sponging with Dakin's solution. The sponging process removes the wound secretion, necrotic tissue, and other débris. The edges of the wound are protected with gauze which is saturated with vaseline. The gauze is prepared by immersing suitable lengths of No. 4 bandage gauze in yellow liquid vaseline, which is sterilized and allowed to cool before using. By following this process the vaseline gauze is easily applied.

"The Carrel tubes are introduced in the wound, the ends attached to the distributors, and the dressing completed as described. In emergency cases, dressings can be delayed two or three days, providing the installation of the solution is kept up. It is absolutely necessary that a free and open incision be used to permit the easy introduction of the tubes and gauze in the wound.

"From day to day films are made from the wound discharge, stained, and examined under the microscope, and when the bacterial invasion has been reduced to vanishing point the wound may be sutured."

This method is probably the most efficient that has ever been introduced for the purpose of sterilizing wounds, and it is equally applicable to civil and to military practice. But it is by no means simple to carry out ; it requires constant supervision by trained observers, and a careful consideration of the clinical as well as the bacteriological aspects before wound closure can be attempted. The solution must be made up by a thoroughly competent chemist, otherwise it will irritate ; and all the details laid down by Carrel must be followed implicitly. When the treatment fails, it is through some error of technique, though the constant attention necessary and the technical skill required militate against its general application.

To be effective, the treatment should start as soon as possible after the infliction of the wound, and should continue until the wound is ready for suture.

4. **Chloramine and Chlorazene.**—In strength of from 0·5 to 1 per cent these are valuable germicides ; they are stable, non-toxic substances, and are excellent substitutes for Dakin's solution when the latter cannot be prepared properly.

5. **Eusol.**—Lorrain Smith and his associates have aimed at a more or less complete liberation of free hypochlorous acid from chloride of lime by the addition of an equal weight of boric acid. Smith's preparation is known as *eusol.*

" i. 25 grms. of eupad (equal parts of commercial bleaching powder and boric acid, intimately mixed and ground in a mortar) are shaken up with 1 litre of water and allowed to stand for a few hours, then filtered through cloth or filter paper. This mixture should be kept in a closely-stoppered bottle and not exposed to light.

" ii. To 1 litre of water add 12·5 grms. bleaching powder, shake vigorously, then add 12·5 grms. boric acid powder and shake again. Allow to stand for some hours, preferably overnight, then filter off, and the clear solution is ready for use. This solution contains :—

	Per cent.
Hypochlorous Acid	0·54
Calcium Biborate	1·28
Calcium Chloride	0·17
Total	1·99

" Eusol is a very satisfactory application, though not so powerful as chloramine, or so stable. Moist pads of eusol or chloramine are excellent dressings when irrigation is not required." *

6. **B.I.P.P.** — In the *Lancet,* August 12, 1916, Prof. Rutherford Morison published an account of wounds treated by B.I.P.P. The treatment is as follows :—

i. Under an anæsthetic, usually open ether, cover the wound with gauze wrung out of 1–20 carbolic acid, and clean the skin and the surrounding area with the same lotion.

* Sherman, *Surgery, Gynecology, and Obstetrics.*

ii. Open up the wound freely, and if possible sufficiently to permit of inspection of its cavity. (In doing this, special regard must be paid to nerve trunks and muscular branches of nerves, since the division of blood-vessels, excepting the largest, and of the muscles themselves, does little harm as compared with the disability following nerve damage.) Cleanse the cavity with dry sterile gauze mops, Volkmann's spoon, etc., and remove all foreign bodies.

iii. Mop the surrounding skin and the wound cavity with methylated spirit. Cotton-wool mops conveying the spirit are used for this purpose, and are introduced on forceps.

iv. Rub well into all parts of the wound with dry gauze a paste consisting of :—

℞	Iodoform, 2 parts	say ℥xvj
	Bismuth Subnitrate, 1 part	,, ℥viij
	Liq. Paraffin, 1 part	,, ℥viij

The powders are mixed together in a mortar, and the liquid paraffin incorporated. The quantity of liquid paraffin required varies according to the bulk of the powders, the bismuth in particular being liable to considerable variation in bulk. A sufficient quantity should be added to form a paste.

It is then advisable to rub down the paste, in small quantities at a time, on a slab with a spatula, to ensure freedom from grit and dry particles of powder.

Dress the wound with sterile gauze, and cover all with an absorbent pad which is held in position by sticking plaster and a bandage. This dressing requires no change for days or weeks if the patient is free from pain and constitutional symptoms.

Re-dressing is very simply done. After removal of the old dressings, the wound is covered with a dossil of wool soaked in spirit, and the sticky and dirty-looking discharge is wiped off the surrounding skin until it is clean. This is done with dossils of cotton-wool soaked in spirit and applied by forceps.

Amputation stumps that need re-trimming or re-amputating can be treated with impunity, provided the clinical condition of the patient is taken into account : it would be unwise to attempt operation while the wound is unhealthy and freely suppurating ; but as soon as it appears clean, flaps can be formed and bone removed, and the whole wound can be sewn up without drainage if the above instructions are followed.

Very often the temperature runs up to 101°–102° for several days in succession, but this need cause no alarm.

A piece of gauze covered with B.I.P.P. is used as an external surface dressing, as it does not adhere to the wound.

Too much B.I.P.P. should not be used—rarely more than a piece the size of a walnut. The great advantage of the method, apart from its effect in checking sepsis, is that it does away with the need for frequent and often painful dressings.

B.I.P.P. poisoning will occur in some cases if the patient is susceptible. I have found it only limited to a blue line on the gum margin ; but (1) bronzing of the skin, (2) stomatitis, (3) diarrhœa and vomiting, (4) delirium (this latter chiefly due to the iodoform)—may occur. If these symptoms arise, the wound must be opened up and the B.I.P.P. must be washed out.

7. **Flavine** and its modifications, introduced by Dr. Browning, is a powerful germicide, and is being now employed extensively. It is used in strengths of 1–1000 to 1–5000. Flavine is a yellow fluid in solution—very slightly irritating in a strength of 1–1000. Gauze soaked in flavine can be packed into a wound, after thorough cleansing, and left there. Where it is impossible to apply Carrel's treatment, and where it is desired to make the dressings as infrequent as possible, this antiseptic has much to recommend it. It is now used in the form of an emulsion, and many wounds, after excision of their margins and necrotic tissue, are sewn up with this emulsion within them.

8. Many other substances have been recommended, and no doubt have their sphere of usefulness; but in concluding this paragraph stress should be laid on the value of the old-fashioned remedy, viz., **Fomentation,** either of boracic, carbolic, or chloramine.

9. For multiple septic wounds, immersion in a bath of **Iodine,** ʒj ad Oj, is of great value.

PRIMARY AND SECONDARY SUTURE.

Primary suture in operation wounds has been considered. Secondary suture is employed when the wound has been cleaned by the above methods, or by the natural processes of repair, and it is in cases of secondary suture that the B.I.P.P. treatment has proved of such definite value. As soon as the bacteriological examination shows that most of the infecting organisms have been eliminated, and when the granulations appear healthy, secondary suture may be employed with safety. It is advisable to free the skin edges by under-cutting, but the main bulk of the granulations may be left alone. This is the method employed in trimming amputation stumps.

But primary suture has been employed in the case of wounds of recent origin, provided that all dead and contaminated tissue has been cut away ; this is called the 'mechanical cleansing' of the wound, and the method varies from a block dissection of the whole tract to a fine dissection of the lacerated and infected walls. If this dissection is carried out with care, wounds may be sewn up with or without antiseptics with an assurance of success. This method has been tried and proved over a fairly long period, and has been eminently successful except in the streptococcal infections. It requires, however, acute surgical judgment and skill, and moreover is not applicable to every wound. At the same time it marks a distinct step in our knowledge of wound treatment, and the reader is advised to consult works dealing specially with this subject.

SPLINT TREATMENT.

One of the most difficult problems that confront the surgeon is the efficient splinting of a limb with large irregular suppurating wounds in different parts. Much ingenuity is often called for in fitting splints in different cases. Only the simplest splints should be employed as a routine. A splint that is complicated is rarely of universal service. For the lower extremity above the middle of the leg there is no better splint than Thomas's bed splint (*see* p. 172), the back slings being of rubber or of perforated zinc. This splint keeps the limb fixed, and allows of access to the wound for dressing. For injuries below the middle of the leg, Jones's skeleton splint is of great value (*Figs.* 153, 154).

For the upper extremity, either the straight splint of Thomas may be employed, the arm being extended—if required, abducted to a right angle (*see Fig.* 103)—or the flexed splint which allows extension to be applied to the elbow (*see Fig.* 105).

Fig. 153.—Jones's Skeleton Splint for Leg.

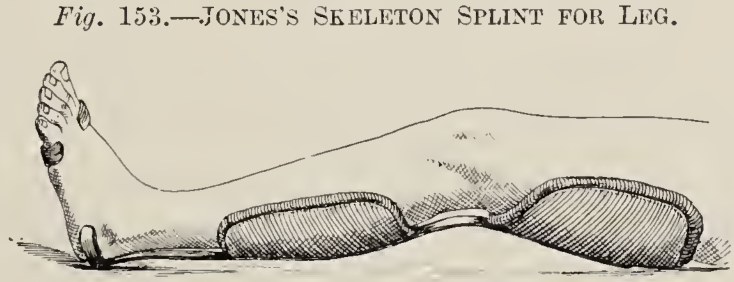


Fig. 154.—Same applied.

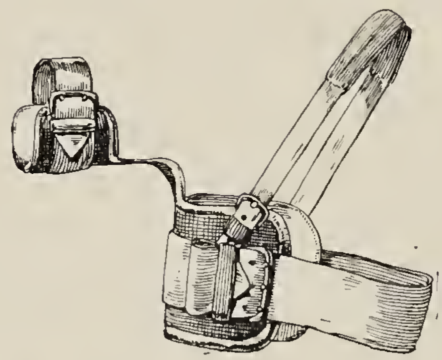
For wounds of the buttock and back, the patient may require slinging from a Balkan frame or in a Sinclair bed.

The first necessity in the treatment of a given case is to deal with the sepsis; if it is possible at the same time to preserve the alinement of the limb, so much the better; but the sepsis must be the first consideration, and the position of the limb should be such that the wound is readily accessible for dressing with the minimum amount of disturbance to the patient. Later, when the sepsis is controlled, a bad position may be corrected.

CONTRACTIONS FOLLOWING WOUNDS.

Injuries to the Soft Parts.—Lacerated wounds during the process of repair form quantities of scar tissue; this tissue contracts, and leads to fixation of any joint in the neighbourhood. This tendency must ever be borne in mind, and treatment adopted accordingly. For example, a lacerated wound on the anterior aspect of the elbow-joint should be treated *in extension*; thus crippling of the extension movement of the joint will be prevented. Laceration of the back of the thigh necessitates an extended limb, while a wound at the back of the ankle requires extreme dorsiflexion of the ankle-joint. Further examples are unnecessary, but every case should be considered from this point of view.

Injuries to the Joints Themselves.—These should be treated on the lines laid down by Sir Robert Jones.



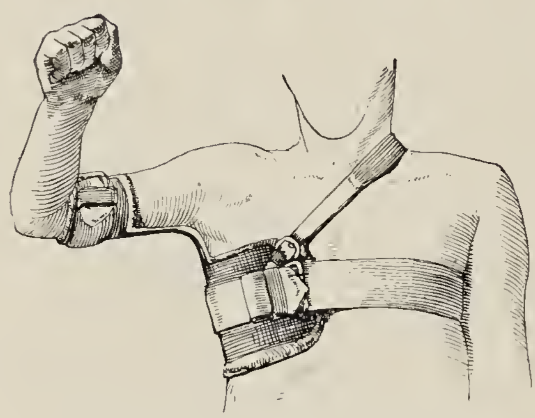


Fig. 155.—Abduction Splint for Injuries to Shoulder.

If ankylosis is likely to ensue, the limb should be placed in such a position that if fixed it will be of the greatest value to the patient.

Shoulder.—"The arm should be abducted to about 50°. The elbow should be slightly in front of the coronal plane of the body, so that when it is at right angles and the forearm supinated, the palm of the hand is towards the face. The arm is placed in this position while the scapula retains its normal position of rest" (*Figs.* 155, 156).

Elbow.—The proper course to adopt will depend upon the patient and his calling, but by far the greater number of men would prefer the fixation to be at just below a right angle—that is, about 70° (*Figs.* 157, 158).

If both elbows will become ankylosed, it is necessary to fix one at an angle of 110° and the other at an angle of 70° (*Fig.* 159).

Wrist.—"All injuries of the wrist-joint should be treated with the wrist dorsiflexed" (*Figs.* 160, 161).

Hip.—Ankylosis should be encouraged in a position of very slight abduction, with the thigh extended, and very slight outward rotation.

Knee.—This joint should be fixed in an extended position.

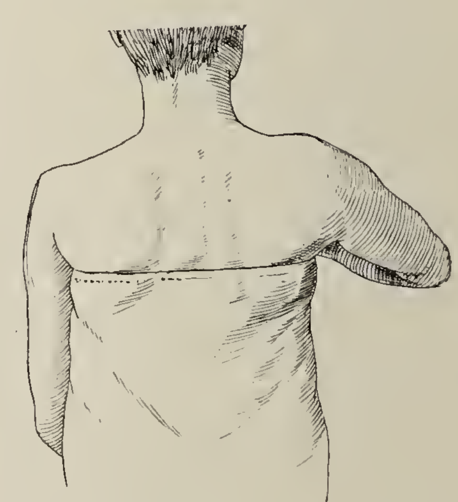
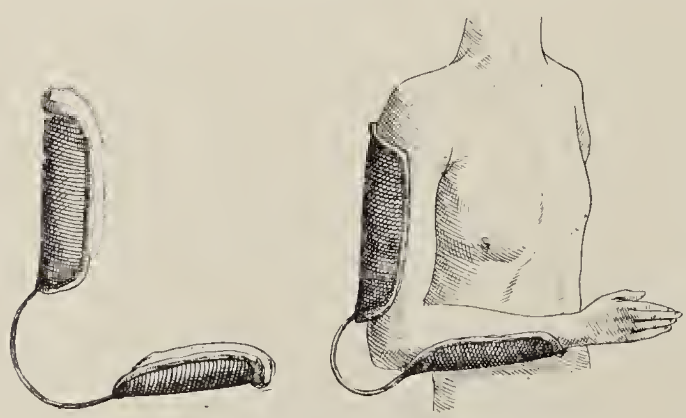


Fig. 156.—Position to be obtained when Ankylosis of Shoulder is likely to occur.



Figs. 157, 158.— Jones's Interrupted Splint for Elbow Injuries.

Ankle.—The foot should be kept at a right angle with the leg, so that the sole impinges on the ground in a slightly *varus* rather than a *valgus position.*

Fixed joints may often be treated by operation or other measures after the wound has

healed. Fibrous adhesions may be ruptured if slight, but if extensive, gradual stretching may be employed. The limb is fixed on a suitable splint—a hinged splint, with troughs controlling the bones above and below, such as the trough elbow-splint. The troughs are secured to the limbs with plaster, leaving the joint

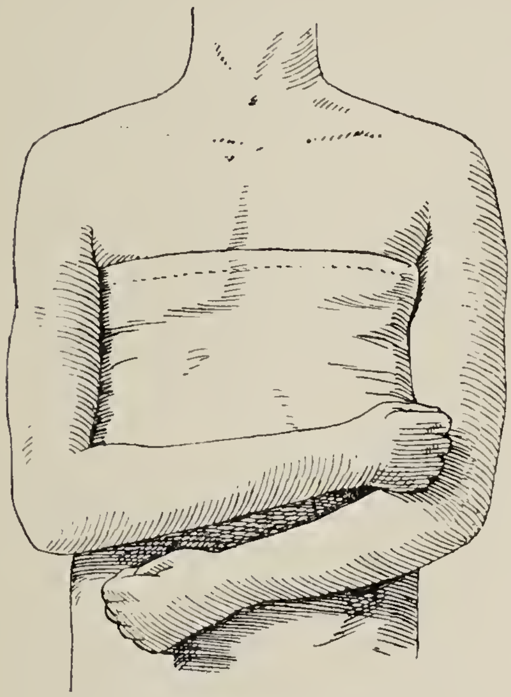


Fig. 159.—Position of Arms in Ankylosis of both Elbows.

Fig. 160.—Cock-up Splint for Hand and Wrist.

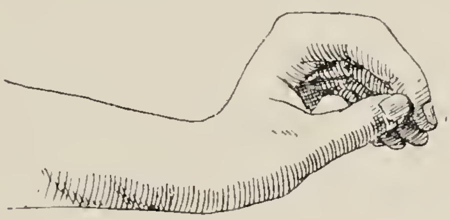


Fig. 161.—Wrist in Dorsiflexion.

free. Day by day the joint is stretched by turning a controlling screw, similar to the screw of a Macintyre's splint, and a little additional range of movement is gained. With patience, practised for a long period, it is astonishing how much the movement may be increased, the fibrous adhesions tending to undergo atrophy.

The operative measures of arthroplasty are not considered here.

THE COMPLICATIONS OF SEPSIS, EARLY AND LATE, AND THE METHODS TO BE ADOPTED TO DEAL WITH THESE.

Immediate Complications.—The immediate complications of sepsis are sapræmia, septicæmia, pyæmia, and secondary hæmorrhage.

Sapræmia is the result of absorption into the blood-stream of a quantity of poisonous material formed in the wound. There may be a rigor, the temperature is raised, and the patient feels very ill. Attention should at once be directed to the wound, as these symptoms show that the sepsis is not controlled—either the method employed for treating the sepsis is inefficient, or the wound requires drainage, or there is some foreign material left behind. Attention to these failing, amputation, if a limb is the part affected, must be considered.

Septicæmia implies the invasion of the blood-stream by bacteria, grave constitutional symptoms supervening—rigors, a raised temperature, wasting, sweating, and diarrhœa. Local treatment of a wound is rarely effective when septicæmia has supervened ; but since only time and bacteriological examination of the blood will demonstrate the distinction between this and the last form of poisoning, the wound

should be thoroughly examined, and any measures taken that appear to be required.

Amputation may be necessary, and all measures are to be taken to stimulate the patient's resistanee. Aleohol should be prescribed, from 4 to 8 oz. in twenty-four hours; a pill of quinine gr. v and opium gr. i is of value for the restlessness and the sweating; and vaccines should be tried.

Many other remedies have been suggested, but they are of doubtful value. One thing is clear, that the system is loaded with poisoned blood, and any measures which ean dilute that blood and assist the organs of excretion to carry off the poisonous products of the bacteria should be used. Saline and glucose injections per rectum or subcutaneously are of great value.

Pyæmia implies the invasion of the blood with baeteria and elot—with the result that the organisms 'colonize' in distant parts of the body, and seeondary or metastatic abscesses arise. Vegetations form on the heart valves, and pulmonary complications develop.

Treatment should be on the same lines as for septieæmia, but amputation, if the patient can stand it, is urgently required. Secondary abscesses are to be opened and drained.

Pyæmie abscesses of joints are eommon, but they clear up, if the patient survives, more quickly after drainage than many other forms of infection.

Secondary hæmorrhage is all too eommon, and often fatal. It has already been dealt with.

Later Complications.—Septie wounds are slow and sluggish in healing, and require stimulation with lotions and dressings. Compound tineture of benzoin, brilliant green, red lotion, and silver nitrate all have their appropriate plaee in treatment. Mainly, however, it is a question of the patient's general eondition, or of the presence of an irritant in the wound. Large granulating surfaees require skin-grafting.

Foreign Bodies and Sinuses.—A foreign body or dead material delays healing, and a wound may never elose until this has been extraeted. Gradually the wound eontraets down until a small opening or sinus is left; this sinus or traek diseharges a variable amount of thick or thin pus, and the margins of its opening are fringed with everted granulations.

Dead Bone.—If the foreign body is a piece of dead bone, it should be removed as soon as the X rays and the probe demonstrate that it is loose.

Repeated probing of these sinuses is to be utterly condemned. We know from pathology that dead bone takes some time—six to eight weeks—to separate from the living. Repeated probing does nothing to assist this, and is painful. Again, the praetiee of paeking gauze into the depths of a sinus is shockingly bad treatment, and the amount of misplaced energy and time devoted to this form of malpraxis is

almost ineredible. Gauze so employed eannot be of value for drainage, and the repeated paeking is dreaded by the patient.

If a sinus needs draining, a tube of rubber or silver is the proper thing to use. If there is dead bone and a small sinus, there is no need to worry about keeping the wound open ; nature will see to that ; a surfaee dressing is all that is required. It is sometimes urged that if the wound be not kept open with the plugging, pus may colleet deeply. This is utter nonsense. In the first plaee, plugging inserted blindly along a deep sinus may aetually block a natural drainage system ; and secondly, if pus does colleet in a wound with a sinus, experience shows that it tracks along the lines of least resistanee, that is, to the surface along the sinus.

All that is required in these sinuses with a known foreign body is occasional dressing with pure earbolic aeid, introdueed along a probe, and an antiseptie surface dressing. The earbolie aeid seems to help the separation of the dead bone.

When the bone is loose, if the piece is small, it is frequently extruded from the wound by the action of the tissues ; if large, an incision must be made through the sinus, and the sequestrum must be extracted.

The removal of a large deep sequestrum is a serious operation, and is not to be undertaken lightly. Grave eonstitutional disturbanee from a recrudeseenee of sepsis may oeeur, and eare should be taken to get the loeal and general eondition as favourable as possible before attempting this operation.

Other Foreign Bodies.—In many cases the pieee of shell, shrapnel, or bullet has been extraeted. In a few instanees, no doubt for very good reasons, this has not been done, and we shall here eonsider two groups of eases : (1) Where there is a persistent sinus ; (2) Where the wound has completely healed.

The general rules that govern our aetions in the ease of wounds reeeived in war should guide us in the treatment of eivil eases also.

1. *There is a Persistent Sinus.*—As already emphasized in the case of dead bone, a foreign body of metallic nature is an irritant, and may prevent healing. Unless the operation is one that will subject the patient to undue risk, the foreign body should be removed. Before attempting this, careful X-ray photographs, with aeeurate localization, should have been prepared, and it is well, when possible, to operate under the X rays.

But all foreign bodies are not opaque to the X rays, and many cases of chronie sinus are due to ligatures or portions of elothing whieh have been earried into the wound. A ehronic sinus whieh does not lead down to bone or to a palpable foreign body should be explored. The opening should be enlarged with a elean cut, and as far as possible by clean disseetion the traek should be opened up for inspection and exploration. In this way any lateral traeks will be detected, and any cause of the sinus ean be removed.

Blind scraping of a sinus is not good treatment as a routine, and is not without danger, as the sinus is septic, and the spoon lays open healthy tissues which become invaded by the bacteria of the sinus. A sinus should always be drained after being opened, or treated as a septic wound. If it is merely scraped and the external opening is not enlarged, a collection of infected clot may be left at the bottom, to become the breeding-ground of the bacteria present.

Some sinuses owe their persistence to their position ; this is especially the case in the buttock, many wound tracks failing to close for much the same reason as does a fistula in ano. Such sinuses should be laid open freely as in the case of fistula, or the whole track may be excised at the time, and the wound may be sutured : it is often wise to defer this latter step until the granulations are quite clean and healthy.

2. *There is no Sinus, but the X Rays show a Foreign Body.*—Probably no operation in surgery has been so misapplied as the extraction of

Fig. 162.—BULLET-EXTRACTING FORCEPS (EGYPTIAN ARMY MODEL).

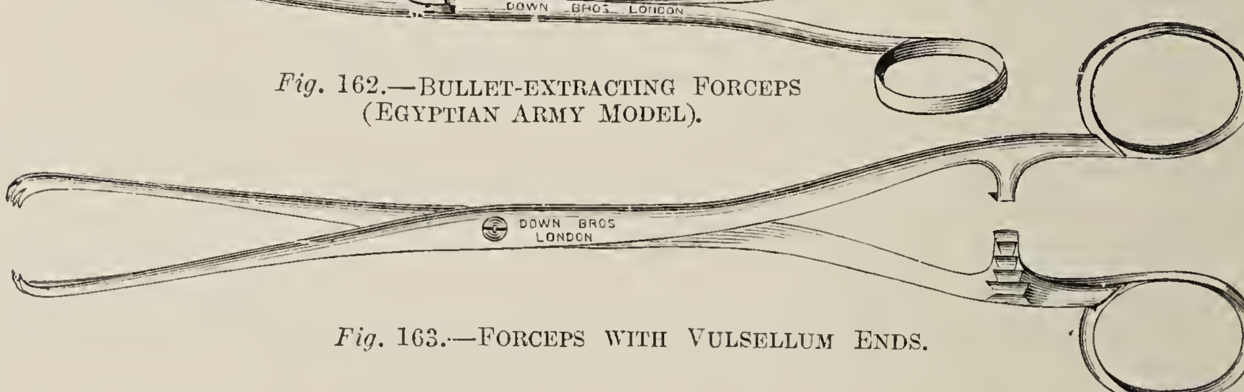


Fig. 163.—FORCEPS WITH VULSELLUM ENDS.

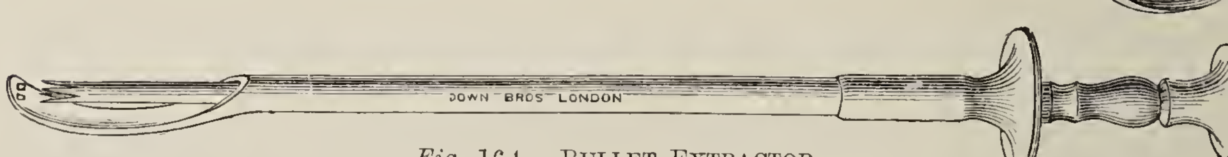


Fig. 164.—BULLET EXTRACTOR.

Fig. 165.—NÉLATON'S PROBE.

foreign bodies which are causing no symptoms, and what is said here applies equally well to bullets or military missiles, and to foreign bodies such as needles, etc., met with in civil practice.

A bullet or piece of needle that is causing no symptoms is for the time at least harmless, and although it is often the importunities of the patient or the patient's relatives which persuade a surgeon, unnecessary operations are still performed.

The casualty room is no place for operations on needles deeply embedded in the tissues, and disastrous results have followed improper attempts to remove them.

If a foreign body is causing symptoms—pressure on a nerve, or local tenderness, or if near a large vessel—it should be removed. If

no symptoms are caused by it, there seems to be no reason to worry about it. The chance that sepsis may arise round it is a remote one, and surely the subject can be reconsidered if this complication arises. If a foreign body is near the surface and can be removed with ease and simplicity, then the operation may be performed. *Figs.* 162–165 show some of the types of instruments that are used for the purpose.

Before any operation is attempted, the foreign body must be localized accurately, and in my opinion the operation should never be performed without the presence of an X-ray apparatus and a screen. Years ago conditions were different, but now in a modern hospital an X-ray operating room should be part of the equipment.

Then a careful consideration should be made of the risks, if any, to the patient ; and if these seem to be undue, as in the case of a bullet in the lung or deep in the thigh, no operation should be done.

In the case of a needle, there is never the slightest urgency ; and it is well known how readily these bodies move about, and how often the operation for their extraction is much more difficult than was realized beforehand.

Only when the foreign body can be felt beneath the skin should the operation be attempted under local anæsthesia.

I would suggest the following rules for the treatment of bullet wounds and foreign bodies :—

1. If there are both entrance and exit wounds, with no important structures injured, apply an antiseptic dressing and wait.

2. If there is no wound of exit, wait until the X rays have localized the foreign body accurately before attempting to extract it. Most bullet wounds heal without suppuration.

3. Unless a bullet or foreign body is very accessible, or from its position is likely to be a source of harm to the patient, *leave it alone.*

4. More harm is often done by the zealous searcher than by the bullet or needle.

5. When there is a large ragged (septic) wound produced by shell or shrapnel, clean, explore, and treat as recommended in the first part of the chapter.

6. When a wound originally septic has begun to clean, do not be in a hurry to search for bits of shell or other bodies ; let the wound heal if it will, then be guided by Rule 3.

7. Do not be in a hurry to operate in these cases, and always have X-ray photographs and apparatus at your disposal before deciding on your course of treatment.

Suppurating sinuses along the track of a bullet which has emerged or has been extracted are to be treated as sinuses.

Sinuses Due to other Causes than Foreign Bodies.—These are sometimes due to inflamed but not dead bone, or to the peculiar infection, or to some deep inaccessible condition, such as tuberculous disease. Much can be done for them by injecting bismuth or B.I.P.P. (made with wax, so that it hardens) to the bottom of the track with a

powerful syringe (Beck's original treatment was with bismuth wax paste), or by the application of Bier's suction cups. Sometimes Wright's hypertonic saline will be found useful, or other antiseptics may be employed. It is well to remember that there is a personal equation in the response of tissues to antiseptics: in one case a mercurial antiseptic will be beneficial, in another harmful; and so with carbolic acid, and the whole series. One should never hesitate to try *varieties*, and it is one of the results of clinical experience that often the suitability of a particular antiseptic can be judged readily.

AMPUTATIONS.

A general consideration of amputations is far beyond the scope of this work; but one or two working rules may be given.

1. In amputating for extreme sepsis, it is often advisable to amputate through a septic area, e.g., the knee-joint, often without any flaps, and then to treat the resulting stump by the various methods described for sepsis. The reasons for this course are:—

i. It is very difficult to get above a septic area; the lymphatics are full of bacteria, and it is impossible to perform a clean amputation without enormous sacrifice of limb, and even then primary healing cannot be guaranteed.

ii. Before the amputation is performed the main artery may with advantage be ligatured in continuity some distance from the site of the proposed amputation, with every antiseptic precaution. This little wound usually heals cleanly, and the risk of secondary hæmorrhage is reduced.

iii. It is always advisable to save as much of the limb as possible, and, if a good deal of the limb is left, it is much easier to form a good weight-bearing stump later.

2. The following are the most useful sites for amputation:—

In the arm: from the insertion of the deltoid to within two to three inches of the elbow-joint.

In the forearm: if the wrist and hand have to be sacrificed, from the insertion of the pronator radii teres to within three inches of the wrist. Any portion of the hand that can be should be saved; stumps of fingers are more useful than the best artificial hand.

In the lower extremity: Syme's amputation is superior to those through the tarsus or metatarsus.

Above the ankle: the best situation is about midway between the upper and lower ends of the tibia: the lower end gives a bad stump; the upper end at the 'seat of election' gives too short a stump.

In the thigh: the lower third is the best place. Amputations through joints are not satisfactory except as temporary measures.

These may be regarded as counsels of perfection, to be followed when possible; it is often neccssary to 'cut one's stump according to one's tissues.'

The question of flap formation is a debated one; except in the worst cases of sepsis moderate flaps of equal length, lateral or anteroposterior, are advisable. The flaps should be of skin only.

If the wound is to be left open, as soon as the acute sepsis is controlled, a great deal of good can be done by drawing the skin of the limb down over the stump by an extension strapping.

All Nerves must be Cut Short. This is easy to advise but often difficult to do, owing to the infiltration of the tissues. Spend time over this, for the cut nerves exposed to the contraction of the granulating wound are horribly painful, and may require dissecting out later. It is often simpler to excise a portion of the main trunk ; for example, in amputation of the leg, the external and internal popliteal nerves may be exposed and excised at the back of the thigh. If the nerve can be properly exposed on the face of the stump, it should be crushed with compression forceps and ligatured with fine catgut in the groove formed by the compression. It appears that this method yields the most satisfactory results.

Re-amputations and Trimming of Stumps.—Secondary operations often become necessary. The exact time at which such plastic operations should be performed varies in every case. If much bone is protruding, and the tissues have been destroyed by sepsis and have widely retracted, the operation should be done as soon as the wound has granulated and has been healthy for fourteen to twenty days. In other cases it is well to try and draw down the skin and let healing take place as far as it will; in some cases it is surprising how well the stump covers.

A sluggish ulcerated surface over the bone, constantly breaking down, requires operation So does an adherent painful bone. But in these cases it is often sufficient to excise a piece—one or two inches—of bone, and draw the skin down over the end. If these operations are performed with the B.I.P.P. technique, they will be found to be very satisfactory.

CHAPTER XXIV

BURNS AND SCALDS

WHEN a large area of the body is involved, burns and scalds give rise to many complications, and they are injuries which it is difficult to treat satisfactorily. In the early stages profound shock and great bodily depression must be combated ; indeed, the mortality following burns is greatest during the first twenty-four hours which follow the injury. This shock must receive appropriate treatment, saline injections being most valuable, and at the same time every effort must be made to prevent any further loss of vitality through prolonged exposure and manipulation. In any case of extensive burns there is a danger of asphyxia, or of poisoning by carbon monoxide. It is necessary to bear these dangers in mind, for prompt performance of artificial respiration, together with oxygen inhalations, may be most effective in meeting these complications. Subsequently there is considerable risk of septic absorption from the large sloughing surface, and fatal issues are due to the development of low forms of pneumonia, duodenal ulceration, meningeal inflammation, and thrombosis. In the final stages much trouble will be experienced in dealing with large granulating surfaces, and with rapidly contracting scars—scars which if left may cause permanent deformity and disablement.

Treatment.—This will therefore be considered according to three main stages : (1) *Immediately after infliction* ; (2) *During separation of the sloughs when repair is taking place* ; (3) *When granulations have appeared and the wound is beginning to cicatrize.*

1. **Immediate Treatment.**—The patient must be put to bed as soon as possible, the clothes must be cut off, and without delay or exposure a dressing must be applied over the whole of the damaged area. If the burn is very extensive, it is better to deal gradually with different regions than completely to strip and expose the whole surface at once. Charred skin or dead tissues should be snipped away carefully with scissors, if this step can be accomplished quickly. Blisters should be cut open, so that the serum can drain away. If the clothes adhere, and if there is a large amount of dirt present, it is advisable either to immerse the part in a warm (100° F.) boracic acid bath, or to soak it with warm boracic acid solution.

A number of different applications have been recommended after the above preliminaries :—

a. Ambrine, or wax dressings. After the preliminary toilet of the burn, the whole surface is sprayed with ambrine or one of its modifications. This is a medicated wax, which forms an adherent airtight

covering to the burn, and does away with the need of frequent and painful dressings. The preliminary toilet and spraying is best performed under anæsthesia, unless the state of the patient forbids it.

b. Oily dressings, which have little tendency to adhere to the burnt surface—eucalyptus oil and vaseline, or the ointment of Réclus :—

℞	Antipyrin	ʒj	Phenol	gr. xv
	Salol		Hydrarg. Perchlor.	gr. ij
	Acidi Borici	āā ʒss	Vaselini (pur.)	℥vij
	Iodoformi	gr. xv		

This can be diluted by the addition of more vaseline if necessary.

c. Antiseptic dressings, which may be left unchanged for some time. Lint soaked in a saturated solution of picric acid is applied to the part, and over this layers of cotton-wool are secured by a bandage. As an alternative an antiseptic cyanide gauze dressing may be used.

Werner's treatment consists in soaking the burnt part in a 2 to 5 per cent solution of carbolic acid, which is anæsthetic and antiseptic. The acid is removed by a second bath of normal saline solution, and the surface of the burn is dusted with a powder composed of acetanilide 1 part, zinc stearate 5 parts ; over this narrow strips of Lister's green protective are placed, and the whole region is finally covered with wet sublimate gauze, and bandaged.

d. Tannic Acid Treatment.—A method whieh is attracting much attention is that introduced by Dr. E. E. Davidson, of the Henry Ford Hospital in Detroit, four years ago. It consists in the use of a watery solution of tannic acid, and for success the following technique must be followed exactly : A solution of tannic acid, 2·5 per cent, in warm water is freshly prepared. A general anæsthetic is given, preferably gas and oxygen, and the burnt area gently cleansed with ether. The tannic acid solution is sprayed on with an ordinary nasal spray atomizer, and dried by means of a current of hot air, or by exposure to the heat of an electric lamp bulb under the bed cradle. Spraying and drying are continued at intervals of one hour until the parts are covered with a thin brown layer of coagulum. In burns of the face, the eyes, nostrils, and external auditory meatus must be protected with moist wool during spraying. The coagulum can be left until it peels off in two or three weeks' time, in second and third degree burns. If pus forms under the coagulum, which will occur only in deep burns with sloughs, the coagulum can be easily peeled off. Wet dressings must not be used.

This method is of particular value where the burnt area is not liable to movement ; but in such regions as the neck the coagulum tends to crack.

Stimulants will be required until the shock has passed off ; later, iron and quinine should be given, digitalis and nux vomica if there is evidence of cardiac weakness. Morphia may be necessary, but must be given with caution.

When the part has been dressed, provided no symptoms of septic

poisoning arise, no attempt should be made to interfere with the damaged part. The dressings may be left alone for several days. But if, as is usually the case, the wound does not remain clean, the dressing must be changed repeatedly, as in the case of any large septic wound. It is often necessary to perform this dressing under an anæsthetic, owing to the pain which it inflicts upon the patient.

2. **Treatment during the Separation of the Sloughs.**—If the burn has not remained aseptic—and it is very difficult to ensure this condition—a considerable amount of offensive discharge will accompany the separation of the dead from the living tissues. At this period, as has been said, there is great danger of complications developing from septic absorption. The separation of the sloughs should be assisted with scissors, so that very little dead tissue remains to harbour putrefactive organisms. All purulent blebs or foci should be opened up, and the dressings should be frequently changed. If the position of the part permits, a weak antiseptic bath is most satisfactory ; this failing, large fomentations applied to the sloughing surfaces are satisfactory. In milder cases an oily dressing, as above described, may be continued until granulations have appeared.

If antiseptic baths or lotions are used, they must be made up very dilute, as the large surface exposed to their action readily permits of the absorption of the poisons from which they are made, and it is no unusual thing for carbolic or mercurial poisoning to occur during the treatment of a burn.

During this stage the patient's temperature will rise, and he will exhibit signs of septic poisoning.

3. **Treatment when the Wound has begun to Granulate.**—The main objects now are to accelerate the healing process and to prevent undue contraction. If the granulations are flabby and unhealthy, stimulating lotions—lotio rubra—should be applied, and general tonics—nux vomica and iron—should be administered. As a dressing, nothing is more satisfactory than a piece of green protective, a number of holes being cut in it to prevent the retention of the discharge, or perforated zinc or silver foil. The protective is placed directly over the granulating surface, and it is then covered by sterilized gauze. Under this treatment the granulations become flat and healthy, while the growing epithelium is not damaged each time the dressing is changed.

If large areas of granulation remain, and the epithelium is sluggish in covering them, skin-grafting must be employed in order to diminish the risk of subsequent contraction.

During this stage every care must be taken to check this contraction, especially in the neighbourhood of joints. For this purpose splints should be employed which exert a force in the direction opposite to that of the adjoining fibrous tissue, and as soon as possible the scar should be massaged and stretched. Gentle kneading and stretching alone are required, or the scar will be torn open.

Scalds or Burns of the Larynx and Pharynx present such special features that they must be mentioned separately.

They are produced generally by drinking scalding liquids, and are thus far more frequent in children than in more sensible adults. (The habit of allowing children to drink out of the spout of a kettle will account for more scalds of these parts than all other causes put together.) But breathing hot air, as in a fire, may produce the same effects, and practically the action of any chemical caustic is the same in this situation as that of the thermal ones.

Scalds of the *Pharynx* itself are not usually very serious, unless the consequent œdema of the tongue and fauces reaches a very high degree ; but when the scald extends farther down, so as to affect the aryteno-epiglottidean folds and the œsophagus, there are both an immediate and a remote risk of complications. The remote one is that the scald of the gullet may cause a contracting cicatrix, and thus become itself a simple stricture, or that the cicatrix may be the seat of a new growth, and thus develop into a malignant one.

But it is with the immediate risk of suffocation through œdema of the larynx that we are concerned here. These cases always cause anxiety, and require very prompt treatment. If, shortly after the accident, there be a distinct difficulty of breathing, from obstruction, the safest plan will be not to wait for more urgent symptoms, but at once to perform *laryngotomy*, or, in young children, a high *tracheotomy*, and then to treat the case with a warm moistened atmosphere, and in all other respects as if it were a case of diphtheria in which the operation has been called for. But often there is a deceitful calm for some hours, and we may be tempted to think that the larynx has escaped altogether, when suddenly the most urgent dyspnœa may be developed.

Whenever, therefore, inspection of the mouth and throat shows that a scalding fluid or a corrosive liquid has passed down it, the patient must be carefully watched, made to breathe a steamy atmosphere, and the surgeon should be ready himself, and have his instruments in readiness, to open the windpipe if necessary.

Skin-grafting may be employed to cover large granulating surfaces, or to make good recent deficiencies resulting from operation. The main objects of the procedure are to accelerate healing, since, although the epithelium may ultimately grow over a large granulating area, the process is slow ; and also to diminish the amount of contraction which always occurs to a great extent during the period of epithelial growth.

Before considering the various methods which may be employed, it is necessary, for success, to insist upon the most *rigid asepsis*. The greatest enemy to any form of plastic surgery is sepsis. Antiseptic lotions should not be used, since they injure the delicate epithelial cells. Sterile gloves should be worn by the operator, fat and epithelial débris should be removed from the patient's skin with ether soap

followed by absolute alcohol, and all instruments should be dry or immersed in normal saline.

Of the various methods employed, three only will be considered : (1) Transplantation of the whole thickness of the skin—devoid of fat ; (2) Transplantation of the epithelial layers, together with a thin slice of the corium (Thiersch) ; and (3) Small particles of epithelium which have been snipped off with scissors are dropped on to a granulating surface, where they grow like seeds in a suitable soil (Reverdin).

The first method is more particularly applicable to recent wounds, such as those caused upon the face by the removal of a large rodent ulcer ; but it may be used to cover granulating surfaces, and it has the advantage of providing a thicker and more resistant covering than the succeeding methods

To prepare a granulating surface for the graft, it is sufficient to apply red lotion on lint, cut exactly to shape, for a few days according to the state of the granulations. The area is well washed with saline (no antiseptic) before the grafts are applied.

If the surface to be covered is that of a recent wound, all bleeding must be checked, and if any antiseptics have been used, the surface must be *well irrigated* with normal saline.

" The skin required is removed from a suitable situation—thigh or abdomen—after careful preparation, in the form of a long ellipse. The incisions are made down to the aponeurotic covering of the muscles. The flap thus includes skin and subcutaneous fat, and is set aside in warm saline solution. The wound is sutured and dressed. The surface to be grafted is now uncovered. The flap is taken from the saline solution, and the fat is removed. This is done by turning it over in the palm and cutting away the fat with scissors curved on the flat. When the surface to be covered is large, the graft may be divided into as many pieces as necessary for distributing it over the surface at suitable intervals. After the application of the grafts, the wound is covered with an oiled silk and gauze dressing as before described."

This method is a modification of that of Wolfe-Krause as suggested by Young, of Glasgow, who advises that the dressings should be changed each day. If this is done the greatest care must be exercised not to displace these grafts, and it is advisable as a precaution that the grafts be stitched to the margins of the wound with a few points of fine silkworm gut at the time of the grafting.

Grafts may be taken from other patients ; the foreskin of a child that has just been circumcised being of great service when there is a large area to be covered. It should be kept in warm saline until the surface to be grafted is exposed. Frog's skin and mucous membranes have also been used.

Thiersch's method is the one usually employed. The details are as follows : A surface of skin on the thigh, arm, or abdomen is carefully prepared by shaving and cleaning, and the granulating surface is

PLATE III

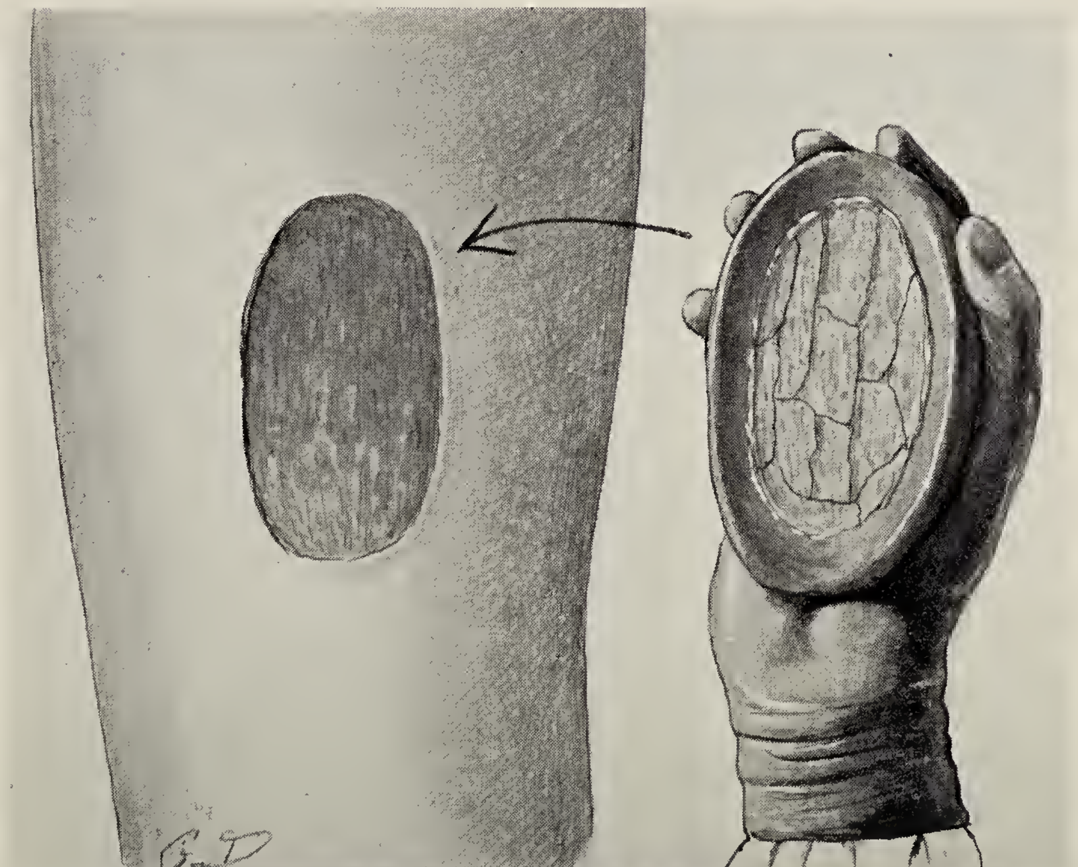
SKIN GRAFTING (*Thiersch*)

A.—Preparing the mould.

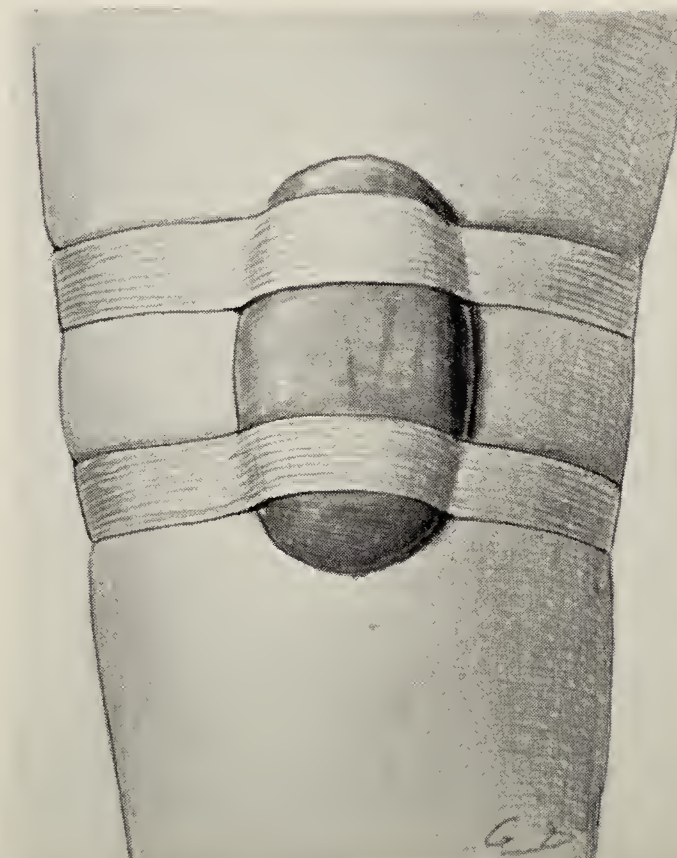
B.—Cutting the graft.

PLATE IV

SKIN GRAFTING (*Thiersch*)



C.—The grafted mould about to be applied to the raw surface.



D.—The grafted mould firmly applied to the raw surface.

washed over with normal saline preparatory to the placing of the grafts. There is some difference of opinion as to how this granulating surface should be prepared. Thiersch advised the removal of the granulations, but this does not always seem satisfactory. If the surface can be prepared a few days previously, as above described, it is in the best condition for the reception of the grafts. If, however, Thiersch's advice is followed, the surface granulations should be removed by gently rubbing with a piece of gauze until the firm deep layers are exposed and the whole surface is smooth and uniform. *Bleeding must be checked with hot saline and gentle pressure.*

Before the grafts are cut, a lump of dental wax, after being softened in hot water, is moulded into a flat sheet a quarter of an inch thick (*Plate III, Fig. A*), and held in contact with the granulating area until it has hardened into an exact mould of the part. Thin slices are now cut from the prepared surface with a sharp razor (*Fig. B*) ; these should just include the tops of the papillary layer, and if cut correctly they will be free from fat and will leave a uniform bleeding surface. They are cut with a gentle sawing movement. A little practice will enable the operator to cut long even strips. The grafts are laid, cut surface upwards, upon the mould, so that when the mould is replaced the grafts will exactly cover the granulating area (*Plate IV, Fig. C*). The grafts must not overlap each other or the area to be covered. The mould is then replaced and *firmly* attached to the affected part by broad pieces of strapping, *uniform pressure* being most important (*Fig. D*). The mould is left for ten days even if there is an unpleasant smell.

The surface from which the grafts were taken should be dressed with some antiseptic ointment, as a gauze dressing is apt to stick to it and cause pain.

Reverdin's method can be easily applied with the above-mentioned preparations and precautions.

Whichever method is selected, success will depend upon absolute asepsis.

The Tagliacozzian method is not considered here.

CHAPTER XXV

OF THE TREATMENT OF ABSCESSES

THE localized collection of pus to which the term abscess has been given is generally treated by incision. At the same time it is necessary to recognize certain stages in the formation of the abscess which have some bearing upon treatment, and further the steps that should be taken to provide adequate drainage and healing.

When an infective process, upon which the formation of an abscess depends, occurs in a superficial region, steps may be taken to cut short the development of the suppuration, as for example in cases of cellulitis and diffuse phlegmons. Free incisions, under such circumstances, followed as they are by the exit of the toxins and by the advent of protective and immunizing lymph to the infected area, are beneficial and advisable ; but when the source of trouble lies at some distance from the surface, and where perhaps from the anatomical relations of the part it is desirable to give nature a chance either of effecting resolution of the inflammatory exudate or of determining it into a definite abscess, local applications—fomentations—are to be employed. In the case of a wound that has become septic, the temperature will have risen, and the patient will complain of pain and discomfort in the region of the wound. The edges of the wound will be looking red and angry, and there will probably be swelling owing to the presence of pus pent up beneath the margins or stitches, if any be present. Such a wound is to be regarded as a septic wound, and treated accordingly (*see* Chapter XXIII).

Detection of Pus.—When an abscess distinctly *points*, there can be no difficulty in recognizing the condition of affairs, but in deep-seated collections of pus, it often happens that the spot where it comes nearest to the skin is indicated, not by an elevation, but by a peculiar sensation to the finger, a mixture of bogginess and dimpling, which we can compare to nothing better than to the feeling conveyed to the finger when it is passed over the keyhole of a door with three or four folds of some soft stuff (say a handkerchief) intervening.

The recognition by *fluctuation* of deep-seated collections of pus, or of any other fluid, which is not making its way at any point to the surface, is a matter of tactile education, which every student must most earnestly and diligently set himself to acquire by practice on every possible occasion, and which can in no wise be taught by words. One extremely common cause of error is due to the fact that the beginner is apt to 'try for fluctuation' with both hands placed transversely to the direction of the muscles, instead of parallel with the

direction of their fibres. The most perfeet fluctuation may be felt by plaeing the fingers across the belly of sueh a musele as the quadriceps extensor femoris, and a tyro may be thus deceived into the belief that fluid is present.

As soon as pus has made its presenee manifest, either by the phenomenon of fluctuation or by a softening or bogginess in an area of induration, no time should be lost in giving it a ready exit. Most abscesses should be opened as soon as they have deelared themselves ; and they should be opened freely, with due respect to the anatomy of the parts concerned, and in such a position that drainage of the contents is favoured.

Methods of Incision.—With regard to the ordinary methods of incision of abscesses, little need be said beyond that which eommon sense would suggest. The curved scalpel, generally ealled a 'Syme's' knife, is often reeommended, but a straight blade is better. For large sacs a eommon dissecting sealpel will be the most convenient form, and for small ones, espeeially if deeply seated, a narrow-bladed, double-edged, laneet-pointed knife is often used; sometimes the instrument whieh gives the least pain, from the extreme thinness of its blade, is the old-fashioned bleeding lancet.

Whatever knife is used it should be very sharp, and the dresser should endeavour to open all abscesses, save those which present some anatomical reason for disseetion or delay, as quickly as possible, making up his mind beforehand how far, how deep, and in what direction, the cut is to be made, in order that one movement of the hand and wrist may suffiee.

Direction of Incision.—The rule is that ineisions should be made in the long axis of the trunk or limbs, unless there be any reason to the eontrary, but that in any case they must be parallel to, and not aeross the direction of, structures whieh it is desired to avoid.

As a rule, abseesses, especially acute ones, must be opened where they point, and this is very often not the spot which would be chosen by the surgeon, who would prefer to make his opening at the most dependent part ; this may necessitate the making of a *counter-opening* by passing a director through the sac from the upper pointing aperture to the bottom of the eavity, and cutting down upon the point of the instrument, so held that it can be felt there through the skin.

If important structures are likely to be eneountered or injured, Hilton's method should be employed : this eonsists in ineising the tissues down to the deep faseia, and inserting a director into the most prominent part of the swelling, or where fluctuation is most obvious, until the pus flows along the groove. The opening is then enlarged with sinus foreeps or Speneer Wells's foreeps, until a traek of sufficient size has been established. When once the opening has been made, it is usually unnecessary to do more than insert a drainage tube, so that the discharge ean find a ready exit. There is no great objeetion to the irrigation of the cavity with weak antiseptics, though it does

no more than wash away the clot which has collected in the cavity. Strong antiseptics and scraping of the cavity wall are in most cases injurious, since the protective barrier of granulation tissue is damaged, fresh lymphatic spaces are opened up, and young vessels are torn across. The necrotic material which often lies against the granulation tissue wall is soon cast off, and can be gently syringed away at the daily dressing. Scraping and strong antiseptics do not facilitate its separation.

Drainage.—All acute abscesses require drainage, though the duration and form of this drainage vary in individual cases. The object is twofold : first, to allow the necrotic tissue, which must separate from the healthy granulations, to come away ; secondly, to prevent the superficial opening closing before the deeper parts have become clean and healthy. Two chief agents are in vogue for procuring drainage, viz., strips of gauze, and rubber tubes (occasionally glass) ; sometimes both are combined. Generally a rubber tube of fair size (for the purpose of draining an abscess of any size no tube smaller than a cigarette should be employed) is the best, but where the bleeding is profuse, or where the position of the abscess is unsuitable for tube drainage, as in ischiorectal abscess, gauze may be substituted. In such cases care should be taken that the gauze is not tightly packed into the cavity ; this prevents shrinkage and contraction, which are essential for healing. Light packing, which can readily be removed, is all that is required.

Generally speaking, acute abscesses are fomented, or covered with some moist absorbent dressing, such as large masses of wool ; but the choice of the dressing which would be most appropriate in any particular case can hardly be reduced to rules.

During the subsequent progress of the case, irrigations of the cavity through the tube once or twice daily are of value, the tubes being gradually shortened as the cavity closes. With regard to the irrigation, it is worth remarking that peroxide of hydrogen, though a remedy of undoubted value, and frequently employed in these cases, must be used with the utmost caution. When brought into contact with blood or proteid matter the oxygen is given off freely, and if it is injected into a cavity from which there is not a very ready exit, the gas so generated may force its way through the walls of the abscess into the cellular tissue, causing serious complications. Drainage should not be too prolonged, since the presence of a tube or strip of gauze is a source of irritation, and sinuses are often caused by a too zealous adherence to the tube over a long period. When the temperature has been normal for four or five days, when the discharge has become clean, thin, and sweet, it is time to think of withdrawing the drain. No definite rules can be laid down, but provided that the superficial opening is kept patent by a small plug, it is often very advantageous to remove the drainage early.

Rest is an important factor in the healing of abscesses. Neglect of

this detail is another cause of troublesome sinuses. The part should be immobilized as far as possible. Splints, bandages, or whatever apparatus may be most suitable should be applied, and, in cases where the conditions of the part permit, gentle pressure will assist the natural process of contraction and obliteration of the cavity.

Axillary Abscess usually arises from suppuration in the cellular tissue or glands of the axilla. The abscess lies beneath the deep fascia, and should be opened by a vertical incision on the inner axillary wall in order to avoid important structures, and the pus should be reached by Hilton's method.

Submaxillary Abscess arises either from suppuration in the submaxillary lymphatic glands or as the result of a cellulitis. Cellulitis in this region is especially serious, owing to the risk of œdema of the glottis supervening. This œdema, which occurs in the aryteno-epiglottidean folds, causes occlusion of the superior aperture of the larynx, and fatal dyspnœa often follows an attempt to anæsthetize the patient. In no instance is the beneficial effect of incisions into the indurated area of a cellulitis more marked than in Ludwig's angina. The incisions may be made either parallel with and under cover of the border of the lower jaw, or vertically in the median line; and if there is dyspnœa when the patient comes under treatment, local anæsthesia alone should be employed.

Ischiorectal Abscess occurs after infection of the fat in the ischiorectal fossa, the infection passing in from the bowel, either through a gross abrasion, such as may be produced by a foreign body, or ulcer, or by means of lymphatic communication. There are two well-recognized varieties of ischiorectal abscess: the acute form, caused in most instances by the *Bacillus coli* or other pyogenic organisms, and the tuberculous. The acute, the ordinary variety, is treated by free incisions, which should extend widely across the buttock at right angles to the anus, and in most cases it is advisable to make crucial incisions over the centre of the fossa, removing subsequently all undermined skin; the finger should then be introduced and all loculi broken into. The cavity should be lightly packed with gauze and allowed to granulate from the bottom.

Cases of ischiorectal, and for the matter of that, anal abscesses, illustrate the importance of rest in order that perfect healing may be secured. The common result of these abscesses is that after they have discharged their contents, owing to the movement of the part and the bad circulation, a sinus or fistula is formed, which necessitates a subsequent operation to effect its cure. For this reason it has been advocated that in all such cases the external sphincter should be divided, and the abscess cavity made continuous with the lumen of the anus, so that the frequent contractions of this muscle shall not interfere with the healing process.

This treatment is advisable if, at the time of active treatment, a fistulous communication with the bowel is evident, but it is unwise

as a routine. If the patient is kept rigidly in bed, lying for the most part on the face or opposite side, healing may occur perfectly. Under no circumstances should he be allowed to get up until a thorough trial of rest has been made. If this treatment is combined with daily dressing and the application of lotio rubra and stimulating injections, in a fair proportion of cases the formation of a fistula may be avoided.

The treatment of the tuberculous variety is conducted on the same principles, but it is often advisable to scrape out the walls of the cavity after the pus has escaped. As a rule the simpler the operation the better in these cases, and as soon as possible the patient should be sent away to the seaside, while those remedies which are of value in combating tuberculosis elsewhere should be actively employed.

Anal Abscess may be described as a modification of the ischio-rectal variety. It is much commoner, and arises from infection of the sebaceous glands and lymphoid tissue which surround the anal orifice.

The treatment should be conducted on precisely similar lines to those used in the former variety, and later, if necessary, any fistula can be dealt with.

Mammary Abscess.—There are three recognized varieties of mammary abscess : the *superficial*, which is no more than a subcutaneous collection of pus of slight extent ; the *intramammary*, which results from an infection spreading into the breast, along the lymphatics or ducts, from a cracked nipple which has been neglected ; and the *submammary*, usually a chronic variety dependent upon caries of the rib, the exciting organism being either the tubercle bacillus or the bacillus of typhoid fever.

Intramammary Abscess.—During the early weeks of lactation, the breast becomes swollen, painful, and red. The abscess presents in one of the quadrants, and should be opened by incisions which radiate out from the nipple. Mere incision, is, however, inadequate in these cases. Owing to the tendency of the pus to burrow into adjacent loculi, the finger should be introduced into the abscess cavity, and all secondary communications freely opened up. If there is pocketing in a downward direction, a counter-opening should be made in the costomammary sulcus. Tubes should be employed for from four days to a week, and the breast should be carefully supported by means of a bandage.

Submammary Abscess.—Every now and then we come across cases where pus is pent up beneath the breast close against the great pectoral muscle, lifting up the whole gland, and coming to the surface at its margin, often at two or more places. The condition results from tuberculous or typhoid infection of a rib, costal cartilage, or sternum. A free opening and thorough exploration of the tissues underlying the breast is the essential treatment of this condition. It will often happen that the natural pointing is at a spot in the upper half of the circle surrounding the breast, and in this place the first opening must be made, but if possible the abscess should be opened by a

curved ineision, and the contents eleaned out ; drainage will depend on the nature of the infeetion. It will usually be necessary to remove the infeeted rib, and in many eases, espeeially those due to tuberele, the wound may be closed completely.

Peritonsillar Abscess, or Quinsy.—(*See under* 'Diseases of the Pharynx.')

Deep Cervical Abscess.—The early reeognition of the presenee of pus beneath the deeper faseiæ of the neek is of the highest importance, yet sometimes it is extremely difficult ; the pus is so confined and so deep, and there is often so much general swelling, that fluetuation is hardly to be made out, while nowhere is there anything like pointing. But pus in this region must be let out as soon as possible, for the eonsequences of not giving it exit may be very disastrous. Burrowing in the direction of least resistanee, the matter may burst into the pleura or pericardium ; or the air-passages or blood-vessels in the neek may be involved in the destructive inflammation.

The constitutional disturbanee is generally very great, and the temperature chart will itself be evidenee of the formation of pus. In cases of doubt an exploring troear may well be used, but when pus is known to be present, a freer opening than that effeeted by a needle is desirable. From anatomieal considerations free use of the knife is dangerous ; therefore the ineision should be made carefully. When the eavity is reaehed the relief is usually immediate and very marked. The opening may be kept patent by a drainage tube, and the eavity syringed out in the usual way.

Superficial Cervical Abscesses.—These abseesses must never be confounded with the foregoing. They are often glandular, or periglandular. If they originate in glandular inflammation, attention should be direeted to the head, where the souree of irritation will generally be found in the shape of eczema or lice, or to the eondition of the teeth, a common cause of cervieal glandular trouble.

Alveolar Abscess, or 'Gum-boil.'—Here again relief should be given as soon as an elastie bulging of the gum indieates the presence of pus. A narrow-bladed sealpel should be used, and the incision should be made close to the alveolus.

Retropharyngeal Abscess is caused by the formation of pus at the baek of the pharynx. There are four eauses of this eondition :—

1. Suppuration at the back of the nasopharynx, possibly from infeetion of the glands or the eellular tissue which drain that eavity—a eomplieation of adenoids, and therefore eommon in young children ; the abscess so formed lies usually in the middle line.

2. Infection of the eellular tissue around the tonsil. Sueh an abseess, being laterally placed, bulges into the pharynx from the side. This is a common variety, and may be called the 'parapharyngeal.'

3. The breaking down of the deep lateral eervieal glands. Such an abscess is not truly retropharyngeal, but lies against the lateral wall of the pharynx, and may simulate the second variety.

4. When tuberculous disease has attacked the bodies of the upper cervical vertebræ, an abscess is sometimes formed which pushes the pharyngeal wall forward and bulges into the mouth.

The anatomy of this last variety is as different from the first two as is its pathology, for it lies behind the prevertebral layer of cervical fascia, and has a greater tendency to track outwards along the line of attachment of this structure. The first two varieties, on the other hand, lie in front of this layer of fascia, and their treatment is different from that appropriate in the last two forms.

The symptoms of a retropharyngeal abscess are difficulty in swallowing—the food tending to regurgitate even through the nose of the child—difficulty in breathing, and in some cases severe dyspnœa. The child cries in a peculiar manner. The diagnosis is made by passing a finger to the back of the patient's throat, and detecting the soft bulging swelling in front of the vertebral column.

Treatment.—In the first two forms, incise the swelling through the mouth, and enlarge the opening with sinus or Spencer Wells's forceps. The mouth should be washed or swabbed out regularly, and the general health of the child attended to. The remaining varieties are usually treated by incision of the neck. The third form has already been considered under the head of deep cervical abscess. The form which arises from spinal caries is on no account to be opened through the mouth. A careful dissection must be made behind the sternomastoid in the direction of the transverse processes of the vertebræ, and the pus must be reached by Hilton's method. "There is always a risk of a retropharyngeal abscess rupturing into the pharynx during anæsthesia, and asphyxia may follow—such cases must therefore be anæsthetized with the head hanging over the end of the table in Rose's position."

Suppurating Bursa Patellæ is a very acute form of abscess which calls for early relief. Of the treatment of the common housemaid's knee we will say something presently, but instances are not at all rare of a suppurative inflammation of this bursa, which may, or may not, have been previously enlarged. The results of neglecting to incise this acute abscess as soon as it is recognized are comparable to, and indeed may be even more serious than, the case of a whitlow. The patella may necrose in part, or altogether ; or worse still, the knee-joint may become involved, if the pus fails to make its way to the surface. On the other hand, an incision made into the acutely inflamed bursa some little time before suppuration has actually occurred, can do no harm, may very possibly prevent matter being formed at all, and will certainly give present relief.

On all accounts, therefore, abscess or commencing abscess of the bursa patellæ requires an incision, which must be free and in the middle line, and which must fairly open up the bursa.

The patient must, of course, be confined to bed, and the leg will be most comfortable when placed on a slightly bent M'Intyre, or on a

back splint with a little extra padding beneath the hollow of the knee. An antiseptic fomentation will be the best dressing, and recovery is usually very speedy.

Popliteal Abscess arises from a number of causes, most commonly from an infection of the glands or cellular tissue of the popliteal space, via the lymphatics, from a sore on the heel. It is a condition that may easily be overlooked. The patient, usually a child, complains of pain in the knee, and the knee-joint is sometimes swollen from an effusion of fluid, and the limb is flexed. Such cases have been diagnosed as various forms of synovitis, the swelling in the popliteal space having been missed. If neglected, the pus will track up the thigh, producing serious damage, and worse still, may infect the knee-joint via the various communicating bursæ in this region. In any suspected case of this kind the popliteal space is to be very carefully examined ; if pus is present, this will be found full, tender, and not necessarily red—because the pus is formed beneath the deep fascia.

Treatment consists in making a free incision on the outer side of the space in front of the tendon of the biceps, evacuating the pus, and inserting a drainage tube. Care must be taken that the tube does not press on the popliteal artery.

Acute Osteomyelitis.—This disease is now considered one of general septicæmia, due to the staphylococcus, the local lesion being of the nature of a 'fixation abscess' of the bone, occurring generally as the result of a minor injury. The seat of election is, for anatomical reasons, immediately on the diaphysial side of the epiphysial line, and most commonly affects the upper end of the tibia or the lower end of the femur. Early diagnosis is imperative, as, though the lesion is only a local manifestation of a general infection, its course is very rapid, and if untreated may well lead to widespread death of the shaft. Delay often occurs owing to confusion with 'rheumatism', but osteomyelitis is sharply distinguished from that disease by the high temperature, the free movement of the neighbouring joint, and by the occurrence in the early stages of a minutely localized tenderness which can be elicited by pressure with the finger-tip.

Treatment.—*Open the bone* by removing a window with a chisel or drilling holes into the marrow cavity. No curetting is allowed. Diaphysectomy is no longer practised even in the short bones. The general infection must then be combated, the first step being to find the primary focus. Many treatments are in vogue, intravenous mercurochrome, collosol manganese, benzol, and vaccines all having their advocates. The patient's strength must be maintained by generous feeding and stimulation, and as most of the patients are young the results are encouraging ; but there is still a heavy mortality from endocarditis, secondary infection of the lung, and multiple pyæmic lesions.

Buboes.—This term is applied to all glandular or periglandular abscesses which occur in consequence of inflammation set up in, or around, the femoral and inguinal glands. The exciting causes are very

various. In scrofulous children, the irritation of eczema intertrigo, or of ascarides, or phimosis, may cause the inguinal glands to break down, while a sore heel or inflamed scratch on the leg may produce the same result in the femoral group.

In adults, similar injuries of the leg but rarely produce a femoral bubo, while (also somewhat rarely) herpetic eruptions about the corona glandis, the irritation of piles or of condylomata about the anus, may be the cause of suppuration about or in the inguinal glands. But, in adults, the most frequent causes of buboes are gonorrhœa, soft chancre, or more rarely the hard or true syphilitic sores ; these buboes are almost always abscesses *around* the glands, which run a subacute burrowing course. They may, however, take on a phagedænic action in patients with broken-down constitutions.

Buboes should always be opened early, from the tendency they have to form long fistulous tracks in the cellular tissues. A vertical incision should be made with a straight scalpel or a Syme's knife, and the abscess cavity kept open, so that it may heal from the bottom. This may conveniently be done by packing it with a strip of antiseptic gauze. The cut is made vertically in order to avoid wounding the superficial arteries in this region. These are, however, often enough divided, and the bleeding must be checked by ligature. The superficial epigastric is the one most likely to be wounded, and being an artery of moderate size may bleed rather furiously for a short time. If fistulous tracks remain, they will have to be laid open and treated in the manner to be presently described.

INFECTED WOUNDS OF THE HAND.

One of the commonest infections, and perhaps the least studied of all the serious crippling disabilities, infected wounds of the hand not only cause a great amount of loss of working time, but lead to permanent deformities and even to loss of life. They may be divided into four categories, each different from the other and needing different treatment : (1) Localized infections, e.g., paronychia, felon, carbuncle ; (2) Tenosynovitis ; (3) Fascial plane abscess ; (4) Acute lymphangitis.

1. **Localized Infections.**—

a. Paronychia starts usually from a hangnail, and tends to chronicity, the pus tracking under the base of the nail.

Treatment.—A vertical incision is made on either side of the nail, the mid-point of the incision being opposite the semiluna. The tissues covering the base of the nail are dissected back as a flap, the base of the nail is cut away, and the wound dressed with a strip of rubber tissue placed crossways under the replaced flap. No sutures.

b. Felon is an infection of the pulp of the finger-tip, and is dangerous because, owing to the dense structures of the pulp, infections may cut off the blood-supply to the diaphysis of the terminal

phalanx, leading to death of the bone. The epiphysis escapes, as its blood-supply is given off higher up.

Treatment.—This must be undertaken early. Do not wait for fluctuation. A coronal incision should be made around the distal end of the finger, and the pulp divided on the flat almost as far back as the epiphysis. A rubber drain is placed crossways under the flap. No sutures. In no circumstances may the incision be made on the flexor aspect of the pulp, as there is a risk of a painful scar; and care should be taken not to open the flexor tendon-sheath, which is outside the area of operation.

c. CARBUNCLE generally occurs on the dorsal surface of the proximal phalanx and ulnar side of the hand.

Treatment.—Incise widely *into healthy tissues.* No scraping. Pack with magnesium sulphate cream.

2. **Tenosynovitis.**—Signs: (i) Exquisite tenderness confined to tendon-sheath; (ii) Flexion of fingers; (iii) Exquisite pain on extending finger, felt most at proximal end; (iv) Symmetrical swelling of whole finger.

The individual tendon-sheaths (*Fig.* 166) must be considered separately:—

a. FROM LITTLE FINGER.—Special features: (i) Extension to ulnar bursa, with œdema of the hand and dorsum of hand; (ii) Palmar concavity *not* lost; (iii) Early infection of space lying on pronator quadratus in forearm, leading to swelling on palmar surface just proximal to annular ligament; (iv) Wrist becomes fixed.

Treatment.—Incise sheath on radial side over proximal and middle phalanx, leaving the part over the articulation. If palm is infected, extend incision from distal flexion crease along radial side of hypothenar eminence as far as the annular ligament. Insert director and cut forwards.

b. FROM RING FINGER.—Special feature: Infection spreads to lumbricals, causing swelling of dorsum of hand, and also to middle palmar space (q.v.).

Treatment (of ring and middle fingers).—Incise radial side, and, if necessary, carry incision $\frac{3}{4}$ in. into palm as for middle palmar space.

c. FROM INDEX AND MIDDLE FINGERS.—Special features: (i) Extension to lumbricals, causing œdema of back of hand; (ii) Extension to thenar space (q.v.).

Treatment (of index finger).—Open along radial side, then dorsally along radial side of metacarpal. Continue as for thenar space.

d. FROM THUMB.—Special feature: Does not affect thenar space, but may extend to pronator quadratus space proximal to annular ligament.

Treatment.—Incise flexor surface of proximal phalanx, enlarge through the thenar eminence, separating muscular heads of flexor brevis pollicis. The tendon-sheath lies to the ulnar side of the thenar eminence. Do not carry incision up higher than 1 in. below annular ligament, or nerve to thenar muscles may be injured.

3. **Fascial Plane Infections** (*Fig.* 166).—

a. Middle Palmar Space.—This space extends from the ulnar side of the middle metacarpal bone to the radial side of the little finger. It lies deep to the vessels and tendons of the palm. It may be infected from the little, ring, and sometimes the middle finger, and, by the lumbricales, tends to infect the dorsum of the hand.

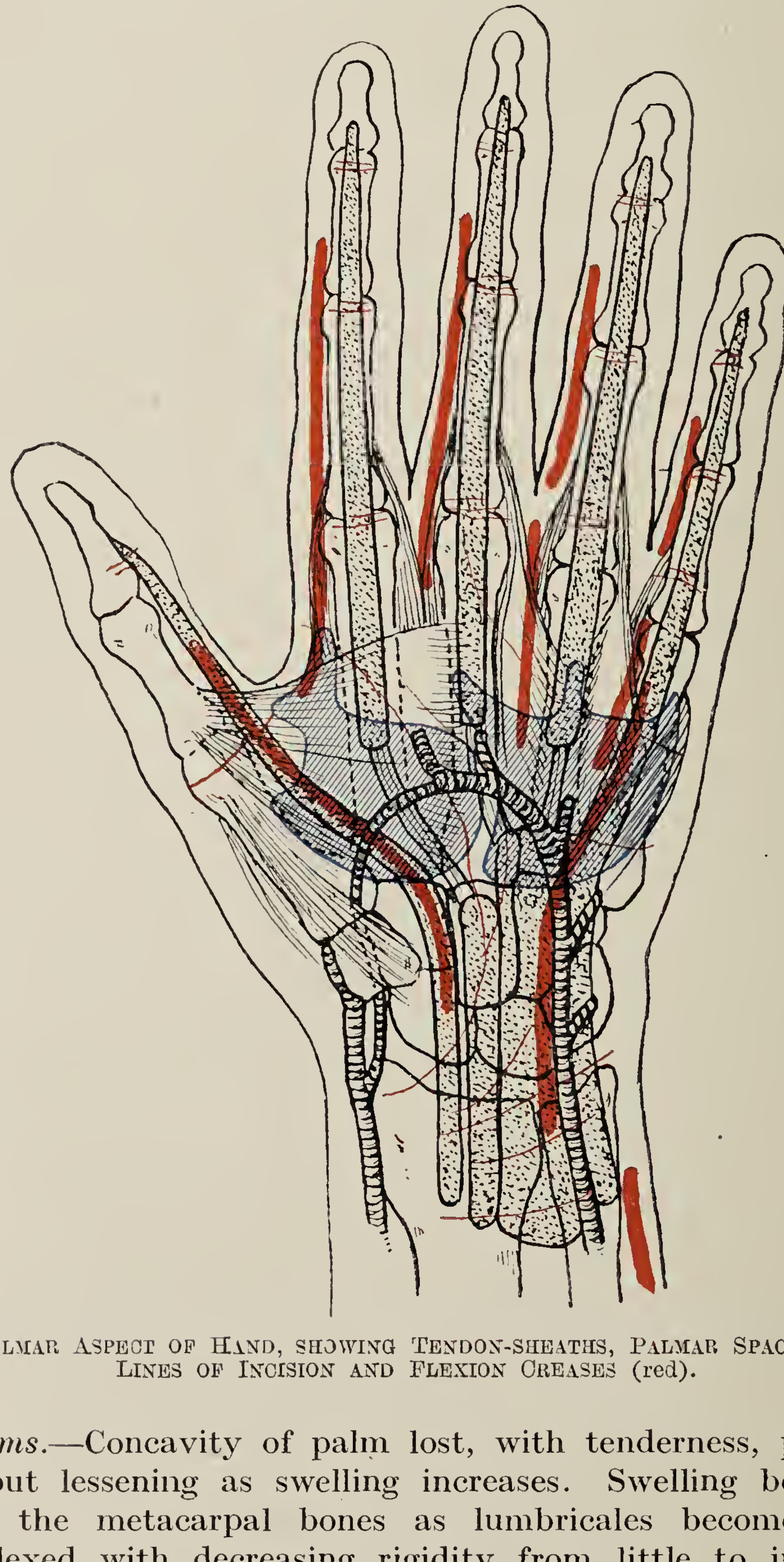


Fig. 166.—Palmar Aspect of Hand, showing Tendon-sheaths, Palmar Spaces (blue), and Lines of Incision and Flexion Creases (red).

Symptoms.—Concavity of palm lost, with tenderness, pronounced at first but lessening as swelling increases. Swelling between the heads of the metacarpal bones as lumbricales become infected. Fingers flexed with decreasing rigidity from little to index. The

dorsum of the hand is often œdematous but never indurated and *must not be incised.* Infection of this space rarely spreads to the forearm, but may extend to the thenar space proximally.

Treatment.—Open by extending the middle or ring finger incisions $\frac{1}{4}$ in. into the palm. Insert forceps. The incision may be extended to a point $\frac{1}{2}$ in. proximal to a line joining the proximal end of the distal palmar crease to the distal end of the proximal crease. Rubber sheet drain.

b. Thenar Space.—Lies on the palmar surface of the adductor transversus, extending from the metacarpal bone of the middle finger over the muscle to the radial side of the hand, stopping at the level of the radial side of the metacarpal bone of the index finger. It is shut off from the dorsum by strong fascia, and from the tendon-sheath of the thumb by much tissue. It is related to the index and sometimes to the middle finger.

Symptoms.—More swelling than in infections of the middle palmar space, because the latter is deep to the palmar fascia. The thumb is pushed away from the hand, and the whole hand becomes huge. Infections never spread from this space to the ulnar side of the middle metacarpal, nor to the forearm, nor to the sheath of the thumb tendon, but they may affect the middle palmar space along the lumbrical anteriorly or directly posteriorly.

Treatment.—Incise along the radial side of the metacarpal bone of the index opposite to its middle on a level with the flexor surface. Pass forceps into the space across the flexor surface of the metacarpal. Rubber tissue drain.

c. Forearm.—Space bounded posteriorly by pronator quadratus, anteriorly by deep flexor, laterally by muscular attachments to radius and ulna. Infected from thumb and little finger.

Symptoms.—Fixation of wrist, swelling on palmar surface of forearm just proximal to annular ligament. If the thumb or little finger sheath has been infected for forty-eight hours without adequate treatment, this space must be considered to be infected.

Treatment.—Incision 2 in. long starting $1\frac{1}{2}$ in. above the tip of the ulna on the lateral surface, carried right down to the bone, dividing the fascial attachment of the muscle in the whole length of the incision. Pass forceps anteriorly to ulna, deep to flexor tendons, and make counter-opening if necessary. The surgeon *must* go below the deep muscular layer even if pus is found superficially. Do not make incisions too short. Rubber sheet drain.

4. **Lymphangitis.**—Marked systemic symptoms. Headache, thirst, fever, restlessness, sleeplessness. Little swelling, perhaps most on back of hand. No pain on extension of fingers, or on pressure over palm or tendon-sheath. Red lines up forearm. Axillary glands enlarged from infection of thumb and index, epitrochlear glands only from ring and little finger.

Treatment.—General. Operate only if inevitable.

General Considerations.—

1. Greatest swelling in loosest tissues.
2. Localized tenderness is most important.
3. In lymphangitis, incise as last resource; in tenosynovitis and pulp infections, incise as soon as the condition is diagnosed; in tissue plane infections, take your time and make an exact diagnosis.
4. All operations must be done under a general anæsthetic, and the area of operation must be rendered bloodless by tourniquet. At the end of the operation the tourniquet may be relaxed partially for twenty minutes to cause (Bier's) passive congestion.
5. Keep patients in bed for at least twenty-four hours after operation.
6. The hand must be put on a splint for forty-eight hours. Fingers semiflexed, hand cocked up, thumb abducted and rotated so that the flexor surface is opposite the flexor surface of the index (approximately as if holding a cricket ball).
7. After forty-eight hours, all drains removed. Hand manipulated under water by surgeon wearing rubber gloves. Active movements encouraged.
8. Do not foment or use arm bath freely.
9. Give plenty of fluid by mouth or rectum.

CHRONIC ABSCESSES.

Chronic or cold abscesses differ from the acute variety in that the three cardinal symptoms and signs of inflammation—heat, redness, and pain—are usually absent. Pathologically they are said to be different, in the absence of pyogenic organisms and leucocytes. This statement is not strictly true, as recent observations have shown that not only are degenerated leucocytes present in the tuberculous variety of abscess—the typical chronic abscess—but that many forms of cold abscess are due to pyogenic organisms of low virulence and activity.

Some of the abscesses considered in the earlier part of the chapter, such as the retropharyngeal, cervical, and popliteal, may present themselves in a chronic form.

Chronic abscesses do not call for evacuation in consequence of constitutional irritation or fever due to mechanical retention of pus, but for some less urgent cause, so that the opening is made more deliberately, and is not followed by that marked, almost instantaneous alleviation of symptoms which is characteristic of the opening of an acute abscess.

The chief ways in which a chronic abscess (non-tuberculous) may be opened are:—

1. By simple incision, with subsequent closure of the opening.
2. By free incision, and, if necessary, counter-incision, and drainage.
3. By some form of aspirator

Free Incision, with the antiseptic precautions before described, is a usual treatment. In all the details of the dressing, and in every other particular, the arrangements are the same as have been previously detailed.

Position of Incision.—This should be made by preference in a dependent place, or a drainage tube may be passed through from an upper to a lower opening. In fact, any of the methods of drainage which have been already described may be employed.

Aspirators.—Of these there are several, but they are mostly modifications of Dieulafoy's, shown in *Fig.* 167—except in the case of small instruments which are used chiefly for exploration—in which the fluid enters the barrel of the syringe, and is thence expelled, by a special arrangement of taps. Smaller syringes still may be used, down to the

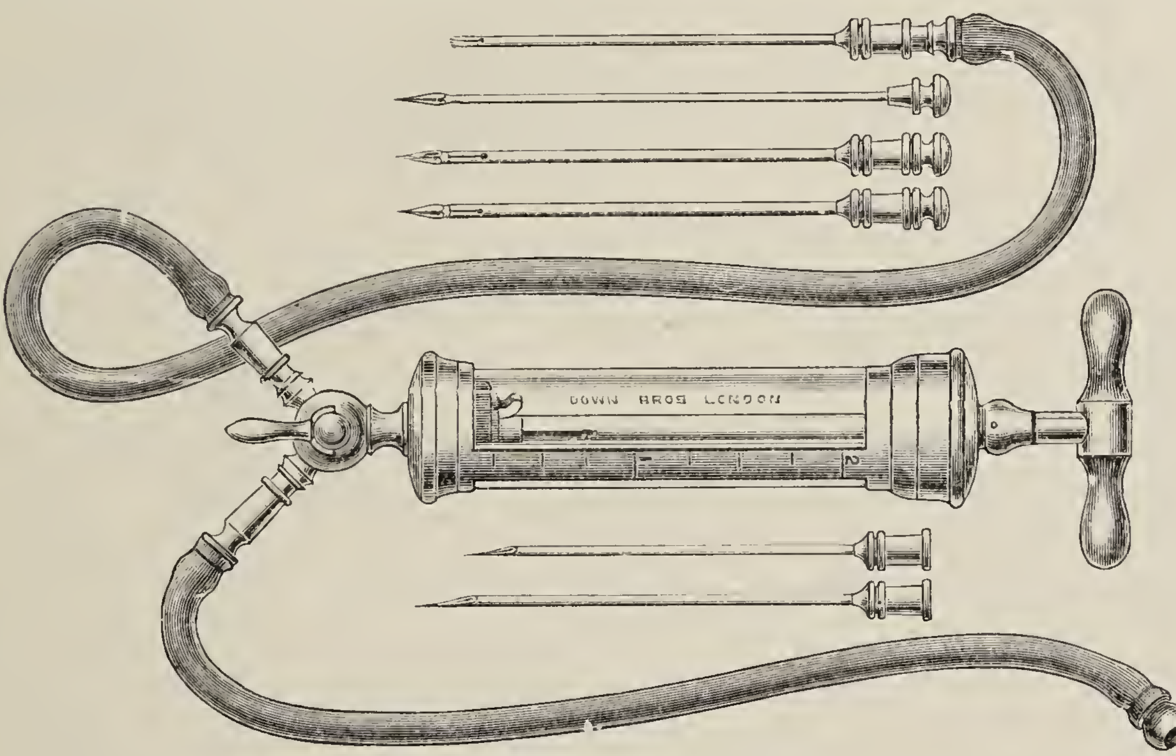


Fig. 167.—Dieulafoy's Aspirator.

ordinary hypodermic syringe, by means of which the nature of obscure swellings, or the existence of fluid in such situations as the pleura or the liver, may be safely proved or disproved more easily than would otherwise be possible. Another form is Potain's (*Fig.* 168).

Before using any aspirator, its connections must be seen to be airtight, and the powers of the syringe to maintain a good vacuum should always be tested.

The aspirator has been largely used by surgeons for dealing with chronic tuberculous abscesses—even psoas abscess—and certainly in many cases the results have been excellent. There is a growing tendency to avoid extensive operations in these cases, and the aspirator often fulfils the object of our treatment—viz., to remove dead or necrotic material, so that bactericidal serum can take its place—in an admirable manner.

Caution needed in use.—Whether the actual puncture be made with

a fine trocar and cannula, or with a pen-pointed hollow tube, it is very important that the needle should be sharp ; if not, there will be great risk of its pushing some piece of tissue, false membrane, etc., before it, so that it is blocked at once, and completely. This tendency to blocking of the aspirating needle is the great drawback to the apparatus, and must always be kept in view.

With regard to the actual insertion of the needle, few general directions are called for. The depth to which the operator wishes to go must be decided beforehand, and the finger should be placed upon the needle to serve as a guide. The cavity should be punctured quickly, so as to avoid pushing the sac wall in front of the point of the instrument, and the direction of the needle should always be perpendi-

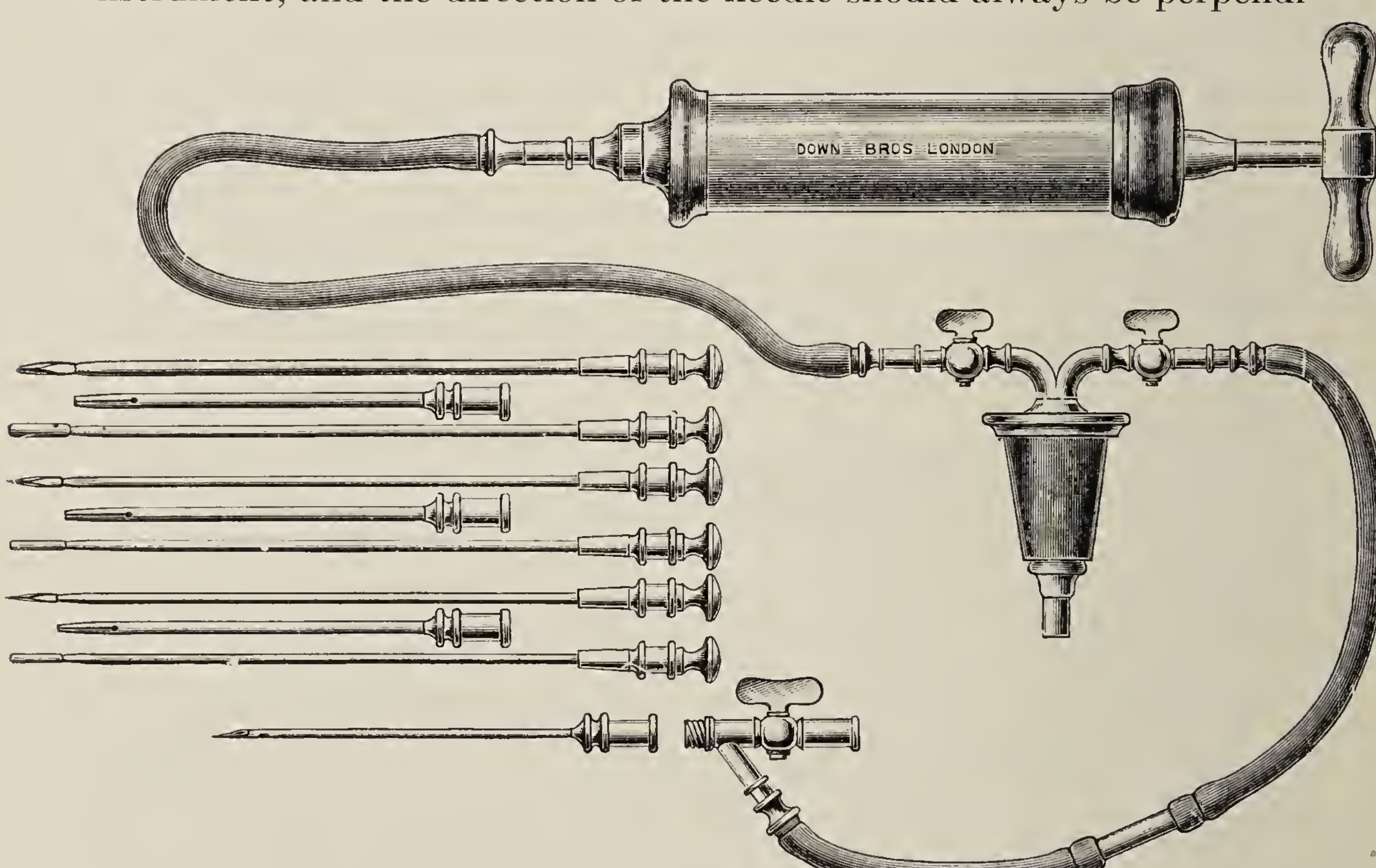


Fig. 168.—Potain's Aspirator.

cular to the surface of the tumour. Aspiration may be repeated on several occasions if the abscess cavity refills.

Hæmorrhage into an Abscess Cavity.—As soon as the internal pressure of the fluid contents is removed, it naturally happens that bleeding from the vessels in the abscess wall may occur. When an abscess is opened, therefore, care should be taken that the parts are not squeezed or roughly handled. The sudden relief of pressure, even without manipulation, may often enough result in a bleeding into the abscess, sufficient to cause delay in its complete evacuation. In most cases the blood-clots become disintegrated and broken down, and escape as débris when the sac is syringed out, so that moderate pressure is all that is required ; but sometimes the bleeding assumes a more serious form ; a blood-vessel of some size may be running

through, or in the walls of, the abscess, and may be eroded ; or a vessel may have been wounded in the opening, or the walls may be in a dangerously sloughy or congested condition. From any of these causes it may happen that the sac of the abscess becomes distended with blood-clot, while from the aperture there is a trickling stream of fluid blood, which serves as evidence that bleeding is still going on.

We have here *inside* the cavity those conditions of distention and high temperature which most favour hæmorrhage, and unless the sac can be emptied of the clots through the existing opening, the only course is to enlarge it and to turn them out.

Tuberculous Abscess : Chronic Psoas Abscess.—This is taken as the type of chronic tuberculous abscess that requires treatment. It is a very common form of the disease which is seen in the surgical wards.

There are three main varieties of psoas abscess :—

1. An early stage, when the abscess has not reached the surface, and is indicated by a tender thickening felt in the line of the psoas on deep palpation of the abdomen.

2. When the pus has tracked out along the fascia iliaca, and presents either as a lumbar abscess in Petit's triangle, or as an iliac abscess internal to the anterior superior spine of the ilium.

3. When the abscess has passed with the psoas tendon underneath Poupart's ligament, and presents to the outer side of the femoral vessels in Scarpa's triangle. From this point the pus may track in many directions along the branches of the femoral artery.

The treatment of the first variety is somewhat difficult, because, to reach the pus from the front, the peritoneum must be displaced inwards or opened. As it is necessary to avoid as far as possible both these manœuvres, the general rule is either to wait until the pus approaches the surface, when it can be reached directly by an incision over the most prominent point, or to perform an operation recommended by Treves, making a vertical incision just outside the transverse processes of the vertebræ, traversing the muscles and lumbar aponeurosis until the cavity in the psoas is reached.

In the case of the second and third forms, a strictly conservative treatment is now the rule, and aspiration is the only method which should be employed. A Record syringe of 10- to 20-c.c. capacity, armed with a 1·5- to 2-mm. calibre cannula, trocar, and blunt probe should be used. The trocar must traverse healthy skin, and it should therefore be entered as far from the abscess as possible, and this also provides for a valvular track after removal. The skin covering the abscess is pressed inwards towards the umbilicus by the fingers of the left hand, which define the limits of the abscess and also put aside and protect the peritoneum. The trocar and cannula are inserted at a point just above and external to the anterior superior spine, and are pushed steadily on till the abscess cavity is entered (*Fig.* 169). The trocar is withdrawn and pus escapes, and the abscess cavity may be further emptied by aspirating with the syringe and by passing the

cannula into various parts of the cavity (the trocar must always be removed before the position of the cannula is altered). When the cannula is removed, the skin slips back and a valvular track results. A single aspiration may, but rarely does, cure a psoas abscess, but it may be repeated, and if at each aspiration the fluid withdrawn is less purulent and more fluid, the case is doing well. Sometimes it may be necessary to use injections, either because the pus is too thick to be withdrawn, or because the cavity refills too quickly, or because improvement is not taking place. To render caseous pus more fluid, Sir Henry Gauvain (Carson's *Modern Operative Surgery*) recommends the cautious injection of thymol 1 part, camphor 2 parts, sulphuric

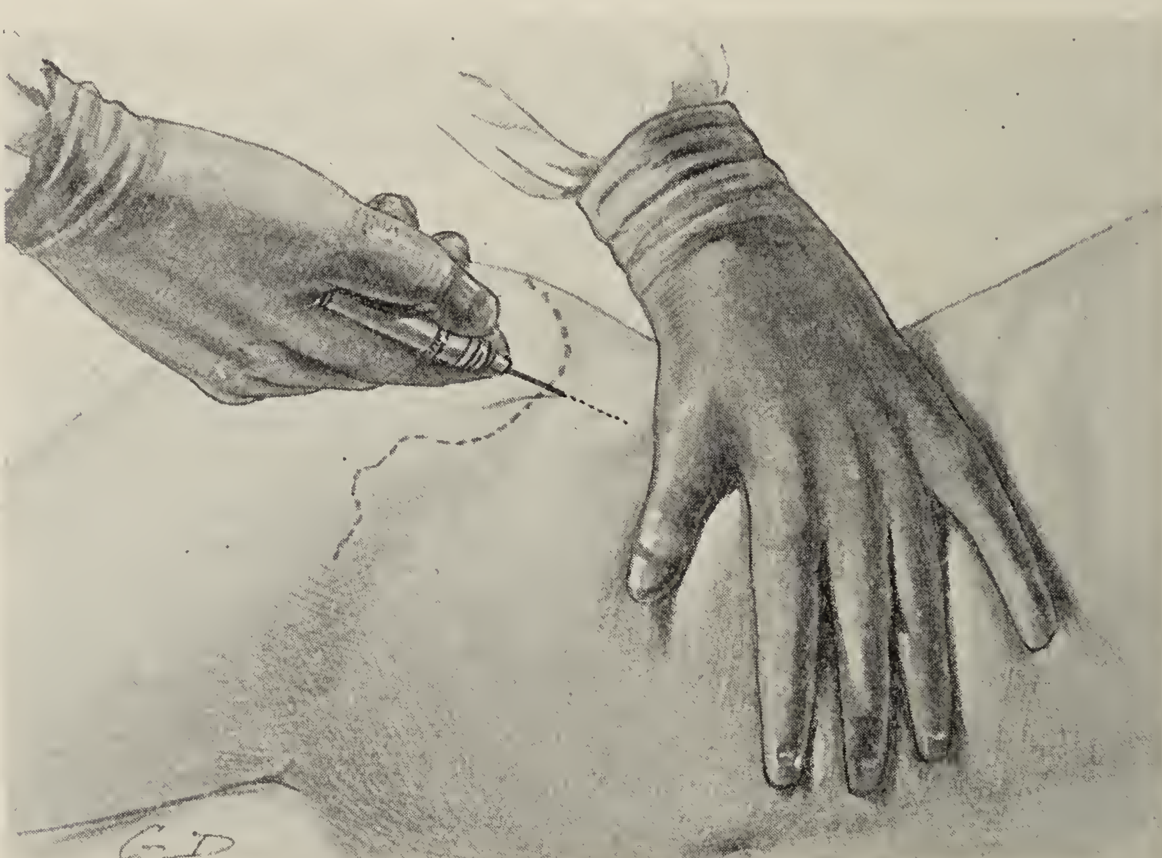


Fig. 169.—Aspirating a Psoas Abscess.

ether 3 parts, in doses of 2 to 3 c.c. If the cavity refills too rapidly, he uses injections of 5 to 10 c.c. of 10 per cent iodoform dissolved in sulphuric ether. If progress is slow, he advises the use of oily iodoform emulsion such as the following :—

℞	Iodoform	grm. v	Guaiacol } Creosote }	āā grm. ij
	Ether	grm. x	Sterilized Olive Oil	100 c.c.

While these rules may govern the treatment of a large psoas abscess, it must be admitted that in certain situations small superficial tuberculous abscesses may be treated in a more radical manner. In cases where there is only a small cavity, and where satisfactory pressure can be applied, not only may a thorough scraping be advised, but the

whole abscess may be dissected out and removed. Thus, in the familiar chronic abscess associated with caseating tuberculous glands in the neck, aspiration will generally prove disappointing, and this is not to be wondered at when we remember that deep to the abscess there is always a caseating gland which cannot be influenced by aspiration. These are typically cases for a carefully planned removal by dissection, and if it is possible to operate before the platysma has become implicated, and if the incision is placed in line with the normal creases of the neck, there is no risk of an ugly scar.

CHAPTER XXVI

OF CERTAIN SPECIAL INFLAMMATIONS

ERYSIPELAS.

THIS is an infective condition of the skin or subcutaneous tissues, due to a peculiar variety of streptococcus. It is customary to consider certain special varieties :—

1. **Erysipelas Proper,** the infection being confined to the lymphatic spaces immediately beneath the epidermis, a form usually unaccompanied by swelling of the tissues except in such situations as the scrotum or the eyelids.

2. **Cellulocutaneous Erysipelas,** a superficial form of cellulitis, indicated by swelling and redness of the part.

3. **Deep Cellulitis,** which is an infection of the sub-fascial layers. Only as the process tracks towards the surface does the skin become red. There are, however, considerable pain and swelling, and the whole part has a brawny, indurated feeling.

The last two varieties may be associated with a large amount of tissue destruction, owing to the sloughing of the skin stretched over the inflammatory exudate.

Treatment.—As these infections are more liable to occur in patients whose constitution is unsound, either from glycosuria or albuminuria, a careful examination of the urine must be made. As a routine, the bowels should be opened by a brisk purge ; subsequently, stimulants and tonics may be administered, quinine and iron being most useful. A rigor is often the first symptom of the superficial variety, and in many cases—especially in children—the constitutional symptoms are most severe. The temperature may rise to 104° or 105°.

Local Treatment consists in applying lotions or protective dressings, leaving the disease to run its course, a form of treatment suited to mild cases ; but any unhealthy focus from which the infection has arisen should be actively treated with pure carbolic acid. One of the best applications in mild forms of the disease is the lotio plumbi c. opio, or, if preferred, gauze wrung out of 1–60 carbolic may be substituted. Ichthyol has been used in the form of a paint with much success.

If the attack is a severe one, and if the part affected is suitable for more active treatment, the tincture of iodine or strong solutions of silver nitrate may be painted ½ to 1 inch beyond the red, sharply defined edge. The object of this treatment is to excite a protective leucocytosis which will be able to destroy the organisms of the infection as they reach this protected zone. Kraske scarifies the area round the erysipelatous rash with a fine knife in order to produce the same

effect, and it is said that a more energetic and satisfactory reaction is produced by this method.

Incisions are not required as a rule in this variety, but when the scrotum or the eyelids are attacked, the loose cellular tissues become swollen and œdematous, and the knife may be used with advantage. Minute punctures only should be made. In alcoholics, erysipelas may attack the mouth and pharynx, an exceedingly dangerous situation, since there is considerable risk of œdema of the glottis supervening. Erysipelas of the face and scalp may give rise to serious intracranial complications, since the infective process may spread along the numerous channels of communication into the cranial cavity.

Treatment of the other cellulitic varieties must be conducted along more vigorous lines. In a few cases it may be advisable to try the effects of rest and moist antiseptic dressings for twenty-four hours, but with this exception, the sooner incisions are made into the inflamed area the better. If active treatment is delayed, the inflammatory process tends to burrow along the fascial planes, and deep-seated abscesses will form. The incisions should be free and numerous, with a due regard to the position of important structures, and they should extend, in the case of the deep cellulitis, right through the deep fascia. Drainage tubes must be employed in those cases where there is a localization of the pus. The use of vaccines may be advisable.

After-treatment will consist in supporting the patient's strength, so that he may be able to neutralize the toxins elaborated in the affected region. Alcohol may be required, and iron, quinine, nux vomica, and arsenic will be of service. The part should be dressed with moist antiseptic dressing. In many cases constant irrigation with weak carbolic (1–200) or boracic acid is indicated, or as an alternative, if a limb is affected, it may be immersed in a bath of the same antiseptic. It is most essential to see that only a very weak solution is used, as the continued application of strong antiseptics is very injurious to the tissues, and may lead to poisoning. As soon as the acute inflammatory phenomena have subsided, massage and passive movements should be cautiously undertaken, so as to prevent undue fixation.

The greatest care must be taken that the infection from these cases is not conveyed to others, especially to surgical or midwifery patients. Cases of erysipelas and cellulitis should be isolated.

BOILS.

A boil is an infective gangrene involving a small area of the cutis, in most instances starting around a hair follicle or in a sebaceous gland ; in this respect it is closely allied to acne. When the infective process is more extensive and involves the deeper layers, it becomes a carbuncle. These infective conditions are liable to arise in those who suffer from diabetes or albuminuria, and it is always necessary to examine carefully for these pathological conditions in any case of extensive infection with boils. Apart from these constitutional

diseases, persons who suffer from boils usually show a very low resistance to the staphylococcus, a point to be specially considered in connection with the treatment.

Treatment.—*Local Treatment* consists chiefly in applying an antiseptic dressing after careful purification of the surrounding skin. In many cases the boil aborts or becomes blind; that is to say, the inflammatory process subsides without suppuration. The general method of covering a boil with a poultice or fomentation is to be condemned, since it tends to disseminate the infection and to cause a fresh crop to erupt.

When once a boil has made its appearance as a conical, red, tender swelling, an excellent form of treatment is to cut out and apply a small piece of Unna's plaster rather larger than the boil, with a small opening in the middle, which should be over the centre of the inflamed area. The boil must be carefully protected from pressure or irritation, either by a pad of gauze or lint, or by means of a small celluloid shield.

Another method, applicable to those boils which have come to a head, is to snip off the projecting point and to apply pure carbolic with the end of a match to the centre of the area.

Gallois treats cases as follows: A solution is made up of iodine (1 dr.) and acetone (2½ dr.); a probe surrounded with cotton-wool is dipped into this iodacetone and applied to the boils, giving them the appearance of so many 'beauty spots.' A piece of absorbent material large enough to cover the whole region is soaked in boric acid glycerin (glycerin 6 oz., boric acid 5 dr.), and this is applied as a dressing over the whole area. The dressing is renewed once or twice a day, according to the amount of discharge. To succeed in this treatment, M. Gallois insists that antiseptic precautions should be observed.

Bier's cupping-glasses may be applied with benefit to the affected parts (*see* Chapter XXVIII).

In cases where there are considerable induration and pain, relief will be afforded by a free incision into the brawny mass.

General Treatment consists in free purgation and the administration of tonics—iron, arsenic, and quinine. The sulphide and the iodide of calcium have been used with much success. Collosol manganese 1 to 2 c.c. injected into the muscles of the buttock has a powerful curative effect in boils and carbuncles. In bad cases it must be given every other day up to 4 or 5 doses, and then repeated after an interval of about a week.

Vaccine Treatment.—The condition of furunculosis, or the general development of boils, being due to a lowered resistance to a staphylococcal infection, Wright has treated patients by means of a staphylococcal vaccine, the object being to increase the opsonic index, and so the general resistance to this micro-organism. The results of this method fully justify its wide application.

CARBUNCLE.

As in the preceding diseases, the association of this condition with diabetes, albuminuria, and other debilitating conditions must always be borne in mind. Not that these states necessarily preclude the successful treatment of carbuncle by operation ; indeed, in many cases there is an improvement in the glycosuria or general condition after the local infective process has been satisfactorily dealt with. At the same time it will be advisable to consider how far the administration of an anæsthetic is likely to be injurious. If the general condition is on the whole good, radical local treatment under anæsthesia should be resorted to ; if, on the other hand, constitutional disease is advanced, the minimal amount of local treatment necessary should alone be attempted.

A second detail of practical importance in connection with the pathology of carbuncle is the fact that the vessels in the substance of the inflamed area are in a state of infective thrombosis, and there is danger of the spread of systemic infection or pyæmia. Carbuncles on the face or scalp are especially dangerous, since the free communication between the superficial veins and the cranial venous sinuses renders the latter liable to fatal thrombosis.

The patient must be liberally fed and well supplied with alcohol, the bowels should act freely, and every effort be made with tonics, iron and quinine, to improve the general health. If the pain is excessive, morphia may be given, though the need for this drug must be made subservient to the state of the kidneys.

Local Treatment consists in :—

1. Complete excision of the whole infected area wide of the disease ; this can only occasionally be practised, but is very satisfactory, the resulting wound, after thorough disinfection, being lightly packed with gauze and allowed to granulate.

2. Scraping out the gangrenous core and the application of pure carbolic acid. It has been urged against this line of treatment that there is some danger of the clots becoming dislodged and carried into the circulation, with the result that pyæmia is set up. If the operation is carried out thoroughly, so that the deep fascia at the bottom of the wound is well exposed, and all the indurated tissue at the periphery of the necrotic area is radically treated, there is little danger of this accident occurring ; it is much more likely to supervene if the operator is over-cautious, and merely stirs up the centre of the process with a timid hand.

3. I have lately treated a number of carbuncles, especially in debilitated subjects to whom I have been disinclined to administer a general anæsthetic, in the following way. The carbuncle is fomented until the central core softens, and then a small piece of lint is cut the exact size of the carbuncle, and soaked in the following : Glycerin of carbolic acid 1 part, glycerin 1 part. The soaked lint is then applied to the

carbuncle accurately ; a small piece of oiled silk is placed over the lint, and the whole is covered with a gauze dressing. If there is any tendency of the lint to shift, it must be kept in place with strapping. I have found this method very satisfactory, as the glycerin excites a free flow of lymph. Care must be taken, however, that only a small piece of lint is used, as the solution of carbolic acid is very strong. Good feeding and tonics are essential adjuncts to successful treatment. Collosol manganese is of the greatest value. One of the best applications is magnesium sulphate cream (which can be obtained in tubes), or a concentrated solution of magnesium sulphate applied by packing ribbon gauze soaked with the solution into the cavity. Frequent dressing is required, as a free flow of serum results.

4. Incisions, usually crucial, may be made into the swelling, and pure carbolic acid may be injected, 5 to 10 minims, into various points of the swelling. The wound is then fomented, and the dead material allowed to slough out.

Under all conditions it is wise to apply fomentations (carbolic) to assist the slough to separate, and a careful eye must be kept on the wound, since the pus occasionally has a tendency to burrow away into the surrounding tissues.

As soon as the sloughs have separated and healthy granulations have made their appearance, the wound should be dressed with protective, and if the epithelium is slow in covering the surface of the wound, skin-grafting may be employed.

NOMA, OR CANCRUM ORIS.

A special kind of phagedænic ulceration is known as *noma*, or when occurring, as is usual, about the mouth, *cancrum oris*. In its pathology it appears to be almost identical with sloughing phagedæna, as it is in its treatment. It is especially a disease of children, and is characterized by the peculiar dryness of the slough, which looks more like an eschar, and by the rapidity of its destruction. It is often almost painless, and may be accompanied by singularly little constitutional disturbance until quite late in the progress of the case. This, the true 'cancrum oris,' must not be confounded with that common ulceration of the mucous membrane of the mouth which is often met with in ill-nourished children.

It is frequently a sequel of diphtheria or scarlatina, but it seems as often to attack children to all appearance healthy and well nourished as those who show signs of malnutrition.

Whenever there appears, in children, in the substance of the cheeks, or on the vulva, *a dusky induration*, with a dry central slough, the case should be looked upon with suspicion, and if it shows any tendency to spread, there is no question but that the right course is to remove the gangrenous tissue at once, and to apply nitric acid, or some other form of cautery, freely ; after the acid has been allowed to act for

five minutes, a lotion of bicarbonate of soda should be applied to neutralize the excess.

One common cause of death in these cases is the poisonous effect of the putrid discharges when these have been swallowed. It is impossible to prevent this altogether, but very much may be done by extremely frequent washing out with such lotions as the chlorate of potash, chlorinated soda, dilute liq. chlori, or sanitas or sulphurous acid. Chlorate of potash should also be freely given internally in doses of 3 to 5 gr. t.d.s.

BED-SORES.

Experience alone as to what *bed-sores* may become if neglected will enable the student to realize the extraordinary amount of destruction which this form of ulceration from pressure can cause, or the rapidity with which it spreads, or the insidiousness of its commencement. It is also very necessary for every surgeon and every nurse to understand that, with the exception of certain paralytic cases, bed-sores are *almost always preventable,* and when present are, as a rule, standing evidence of *neglect or mismanagement.* But, though we will not qualify this assertion further, it must be allowed that sometimes it is extremely hard to prevent soreness, as, for example, in the case of hip disease with extreme emaciation, contraction of both legs, and suppuration. Sometimes, again, tissues have such a low vitality that it seems as if the least touch would produce a slough ; still, with incessant watchfulness, bed-sores *can* be prevented, although once begun they are very hard indeed to arrest or to heal.

In *warding off* the formation of bed-sores, attention must be specially directed to the following points :—

1. The *bed* must, in all cases, be smoothly made, elastic, and soft ; a spring mattress is often a great help, and water cushions may be used for the buttocks. But in cases where there is a well-marked tendency to soreness there is nothing like a *complete water bed.* In filling one of these beds care must be taken to have the water properly warmed, and not to put in more than will just support the patient.

2. In every possible way *continuous pressure must be avoided* upon the parts which are liable to become sore, such as the sacrum, trochanters, ischial tuberosities, heels, occiput, elbows, or the spines of the scapulæ. Taking every precaution (when precaution is needed, as in fractures) against doing local harm by movement, in some way or other it must be managed that the patient shall shift his points of pressure upon the bed, lying now a little low, now a little high ; first with the head to one side, next day turned slightly over (for the least shift is as efficient as a great one) to the other ; a pillow may be put under the knees one day and omitted the next.

3. Something may be done to improve the *nutrition of the skin* by bathing with stimulant lotions (whisky or brandy and water is a common application). Starch or violet powder should be freely used,

and if the tendency to soreness appears imminent, the skin, which will be over a bony prominence, should be strengthened by washing it with brandy and white-of-egg mixture, or spirits of wine and perchloride of mercury lotion 1–2000, and the sore or threatening part protected by a circular pad of wool or lint.

4. *Absolute cleanliness*, as regards removal of excretions, is another essential in the prevention of bed-sores, for nothing softens the skin more and makes it more liable to break down than to be constantly wet with urine or foul with fæcal matter. Incontinence of either or both must make one doubly careful.

Nowadays, in hospitals or where skilled nursing has been employed from the first, such precautions as we have mentioned will be sufficient to prevent soreness altogether, or at the worst to limit it to a superficial excoriation. The cases we meet with where true ulceration is present are those where there has been previous neglect of nursing care, through ignorance or poverty.

Such cases are not infrequent among those who come at last to be hospital in-patients, and whatever the nature of the original illness may be, the bed-sores will count heavily against recovery. These ulcerations are indeed very hard to dress ; they present the characters of deep foul sloughing ulcers, not generally painful, but tending to destroy all the soft parts between the skin and the bone, and often complicated by necrosis of the bone itself. The great point then is to remove all pressure, and to get the ulcer to begin to clean.

If a sore has already developed, it must be dressed with some antiseptic ointment, such as boric ointment, or with resin ointment if a more stimulating preparation is required.

Very much will depend upon whether there is improvement of the constitutional condition or the reverse. If there be general recovery, local recovery is often extremely rapid when once it is started.

CHAPTER XXVII

ULCERS

ULCERS are wounds which are slow in healing, as the result of either constitutional disorders—diabetes, albuminuria, anæmia, etc.—or of local disease. The first essential in the treatment is to deal with the constitutional disease as far as possible, so that the tissues may the better respond to local surgical measures. When grave constitutional disturbance is present, no active operative treatment should be undertaken.

Local Treatment will consist in encouraging a healthy reaction, so that fresh, active granulations may form, which can be covered either by the natural growth of the epithelium at the periphery, or by skin grafts transplanted on to the surface. When once an ulcer has become healthy, and shows signs of active healing, all that is necessary is to protect the part from undue pressure or irritation, and to facilitate the growth of epithelium. For this purpose nothing is better than strips of green protective, perforated to allow the discharge from the granulating surface to escape, the whole area being subsequently covered by an antiseptic gauze dressing. The gentle pressure of the protective keeps the granulations flat and allows the epithelium to grow unchecked and uninjured over the surface of the ulcer. The limb should, when possible, be kept at rest until healing has taken place. In any case of ulcer, the venous return from the parts should be assisted as much as possible, either by an elevated position of the limb, or by firmly bandaging from its extremity to a point well above the situation of the lesions. Certain kinds of ulcers, however, will require special treatment

The Inflamed Ulcer is one in which an active infective process is at work, causing increasing destruction of the tissue and acute inflammatory phenomena. It arises in old neglected ulcers which have been contaminated by dirty dressings. The patient should go to bed, and the leg should be elevated and dressed with moist antiseptic gauze or carbolic acid fomentations. If the surface is not a large one, it should be painted with a solution of strong carbolic acid. A careful watch must be kept for a spreading cellulitis.

The Callous Ulcer is one the edges of which are everted and indurated, and the base is covered with small, unhealthy granulations. There is usually a considerable amount of matting together of the surrounding tissues, and sometimes in long-standing cases the ulcer is adherent to the bone. In order to procure healing, it will be necessary to stimulate the callous surface, either by applying blisters to the edges

and margins of the ulcer, or by scraping away the everted, indurated margin. In addition, it is often advisable to incise the tissues deeply about one inch from the margin of the sore, so that contraction may take place. If such ulcers are thoroughly scraped and carefully dressed, or if the limb be kept at rest and elevated, they will soon become healthy. Skin grafting may be required in the later stages. Calcium iodide in 3-gr. doses thrice daily has been stated to give marvellous results in cases of chronic ulcer. It may be used in conjunction with any of the above methods of treatment.

The Anæmic Ulcer is a weak, avascular condition which occurs in anæmic women. There is no thickening as in the callous variety, but there is no attempt at healing. The administration of iron by the mouth, and the application of stimulating dressings—lotio rubra, Unna's plaster, or friar's balsam—will give satisfactory results.

The Irritable Ulcer is a painful condition due to the exposure of an inflamed nerve filament in the base of the ulcer. The point of tenderness should be accurately localized, and the nerve fibres divided a little distance above the ulcer or the tender point. Subsequently the ordinary treatment should be undertaken.

The Varicose Ulcer is the common variety seen in the out-patient department. It is very difficult to treat unless the patient will consent to remain in bed. If the so-called ambulatory treatment be adopted, a certain number will heal slowly: this consists in 'strapping' the ulcer with Unna's gelatin bandage, which supports the limb and prevents it swelling. The objection to this treatment is that the dressing has to be frequently renewed when the discharge is copious. Another method is to encourage a healthy reaction by stimulating lotions or ointments—the cyanide of mercury ointment is an excellent application—and to bandage the limb firmly from below upwards with a crêpe Velpeau bandage: this should be put on in the morning before the foot begins to swell, and the patient should walk or stand as little as possible. In some cases benefit will result from excision of the dilated veins. Unna's 'gelatin' plaster is made up as follows: Gelatin, 5 parts; oxide of zinc, 5 parts; boric acid, 1 part; glycerin, 8 parts; water, 6 parts.

Unna's plaster, which must not be confused with the above, is a powerful antiseptic preparation with very stimulating properties; it should be cut out the exact size of the ulcer and applied to the surface.

Wright's gelatin-formalin treatment has given good results in some cases of chronic ulcer.

Varicose ulcers are liable to bleed when the destructive process has attacked one of the dilated veins. Properly treated this is not a serious matter, but neglect or carelessness may lead to fatal results. A firm antiseptic dressing should be applied over the bleeding ulcer, and the limb should be carefully bandaged from below upwards. The patient should be confined to bed until the ulcer shows signs of healing, and the limb should be elevated above the level of the trunk.

The Perforating Ulcer is a destructive condition of the tissues arising from suppuration in a bursa beneath a callosity or corn. The suppuration tracks into the joints, and may burrow for a considerable distance into the sole of the foot. It is usually associated with tabes dorsalis, but occurs in other conditions. The ulcer should first be cleaned by moist antiseptic dressings, fomentations, or baths, and all the thickened epidermis should be cut away. If the sinus is unhealthy it should be scraped. The cavity should be plugged with gauze soaked in lotio rubra or friars' balsam, and the track should be allowed to close from the bottom. During treatment the patient should not walk on the affected foot.

The Phagedænic Ulcer is an acute destructive process, occurring in alcoholics or diabetic patients. It may or may not be associated with syphilis. In appearance the ulcer resembles the inflamed variety, but the process is more acute, the tissue destruction and sloughing are more extensive, and the constitutional symptoms are more severe (*see* 'Syphilis').

As a stimulating dressing for ulcers which are *clean* but slow to heal, nothing is better than the so-called 'red ointment.' This is an ointment made up of *scarlet red* 10 per cent, with vaselin or lanolin. Scarlet red has the peculiar power of stimulating epithelial growth.

CHAPTER XXVIII

OF PASSIVE CONGESTION (BIER'S TREATMENT), OF VENESECTION, CUPPING, ETC., OF BLISTERS AND OTHER METHODS OF COUNTER-IRRITATION, AND OF VACCINATION

PASSIVE CONGESTION (Bier's Treatment).—This treatment, which was introduced by Bier, of Kiel, aims at an imitation of the phenomena of inflammation, the active hyperæmia of the state being copied by a passive congestion which results from obstruction of the veins. It is applicable to a large number of different disorders, especially those of the extremities, such as whitlows and suppurative states of the joints and tendons. It is also of service in tuberculous disease, and a modification of the method may be employed for the treatment of sinuses and similar lesions. To practise the treatment,

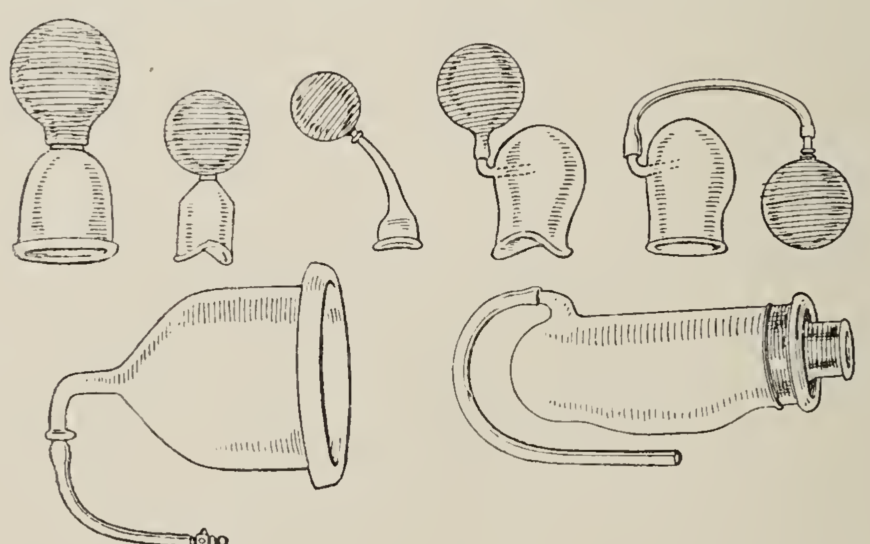


FIG. 170.—CUPPING GLASSES AS USED IN BIER'S TREATMENT.

a soft broad rubber bandage is bound round the limb on the proximal side of the lesion, and should be applied with sufficient tension to render the part below bluish-red and swollen, not cyanotic or anæmic. Above all, it must not affect the pulse, which should remain unchanged. If properly applied, except in neurotic subjects little or no pain is caused ; indeed, the throbbing agony of whitlows is markedly relieved by the application of the bandage. The length of time during which this bandage may be applied varies in different cases ; it is better to start with short periods of half to three-quarters of an hour, and later the bandage may be retained in acute cases for as many as twenty out of twenty-four hours without inconvenience or injurious effect.

With the application of the bandage the morbid tissues are flooded with serum, which has a beneficial effect in combating any infection which may be present. If any wounds have been made they will be found to run freely with serum during the time the bandage is applied. One important result of the treatment is that small incisions only may be required for the relief of whitlows, abscesses, and septic states, the general duration of treatment being thereby shortened considerably. In the case of sinuses which from their position are not amenable to the application of the bandage, good results can be obtained by the application of cupping-glasses or a suction apparatus ; a test-tube which will just fit over the margins of the sinus is an excellent substitute for a cupping-glass. The action of these glasses is to cause a free flow of curative serum over the morbid tissues, stimulating them to activity and healing. This treatment may be combined with the application of Wright's solution, which consists of 4 parts of sodium chloride and 1 part of sodium citrate to 120 parts of water.

Venesection.—The practice of venesection is so much out of fashion that probably the majority of house surgeons now in offiee have never seen the operation performed, still less performed it themselves. We are suffering from the reaction that followed the abuse of the practice in the earlier years of the nineteenth century, and though we sincerely hope that neither we nor succeeding generations will ever see its revival to the excess of former times, there is little doubt that it might be employed more frequently than is now the case.

The veins which are opened for the purpose of letting blood are, one of those at the bend of the elbow, the jugular, and, much more rarely, the internal saphena at the ankle. The method is much the same in each case, and we will deseribe in detail only the commonest, namely, bleeding from one of the veins at the bend of the elbow, usually the median basilic.

The Method.—The patient, who should be sitting, is directed to hang the arm down so as to produce turgescence of the veins. A piece of bandage is then tied tightly round the arm, a pad being placed over the trunk vein on the inside, and the bandage knotted over that. The hand should then be raised to the horizontal position, and be made to grasp a strong pole resting on the ground (the origin of the barber's sign-pole) ; a broom handle will do very well, or even a bandage. The limb is thus steadied, and the forcible muscular flexion aids the venous fullness.

Supposing the median basilic to be selected, the thumb should be placed just below the spot chosen for incision, so that the vein, and the skin over it, are steadied, and the blood is prevented from spurting out. The surgeon then, with a lancet, or a very sharp knife (the former is best, from the extreme thinness of its blade) incises the vein obliquely, cutting it about half across. On removing the thumb, blood should immediately flow in a somewhat forcible stream, and this should continue until about five or six ounees have been removed ;

it will then generally slacken, and if more blood is to be drawn, the surgeon must rub the limb from below upwards, and direct the patient to open and close the hand alternately, or to flex and extend the elbow, so that the muscular contraction may aid the flow.

When as much blood as is required has escaped, the ligature on the arm must be relaxed, the arm raised, and a pad placed upon the wound. The pad should be secured by a double figure of **8**, the ends being tied in a bow, or reef-knot, over it.

Complications of Venesection.—If the instruments are perfectly clean, diffuse inflammation can hardly occur, but in older and ruder days this was not infrequent.

A still more serious accident seems to have happened somewhat unaccountably often, namely, a puncture of the brachial artery, or an opening of it in mistake for the vein. This sometimes resulted in the formation of an arteriovenous aneurysm, or in an aneurysmal varix, and sometimes in consequences still more serious.

It is very necessary that the wound in the skin and that in the vein should exactly correspond, and every care must be taken that the former does not slip over the latter during the incision. This is best prevented by using a very sharp lancet, and by fixing the vein firmly.

In cases where the vein is difficult to find, a careful exposure of the vessel by dissection will prove of great service. (*See* 'Infusion of Saline,' p. 53.)

Bleeding from the Jugular Vein is sometimes adopted in children because of the small size of the arm veins, and in adults for other reasons. The operation is conducted on the same principles as for bleeding from the arm, but the compress to produce distention of the vein must be applied very firmly above the clavicle, outside the sternomastoid, lest air should enter. The vessel is incised upon the sternomastoid, in its long axis, as the platysma fibres here cross it obliquely. The after-management is the same as before, but the pad must be placed on the wound before the compress over the clavicle is relaxed.

Arteriotomy is still more rarely performed than venesection. The temporal artery, or one of its branches, is the only vessel opened for this purpose. It should be half cut through with a lancet, as in the case of the vein, but transversely ; and when the desired amount of blood has escaped, the division of the vessel should be completed and a very firm compress applied, which should be left undisturbed for four or five days.

Cupping.—By means of 'cups' the blood may either be merely drawn to the surface by taking off the atmospheric pressure, or it may, having been thither attracted, be removed by a scarificator. The former proceeding is 'dry,' the latter 'wet,' cupping. The nape of the neck and the posterior surfaces of the thorax and loins are by far the most common situations, but any part which will hold the glass will do.

Dry Cupping.—In order to cup successfully, some dexterity is required. The principle on which it depends is the creation of a considerable vacuum beneath bell-shaped glasses (*Fig.* 171), which are made in various sizes. These glasses are sometimes made so that they can be attached to an exhausting syringe, like the bell-jar of an air-pump. But in skilful hands a better vacuum is obtained by quickly rarefying the air by heat. A good cupper will do this by simply putting a lighted paper spill within the cup for an instant and immediately applying the latter to the surface of the skin ; but for most people it will be easier to put a few drops of spirits of wine into the cup, and to distribute the spirit over its interior. A pledget of cotton-wool placed on a stick should then be dipped in spirit, lighted, and mopped round the inside of the glass. This will produce a large but momentary flame, and as soon as it is alight, the cup should be 'clapped' upon the required place. The flame will be immediately extinguished, and the vacuum will show itself by an almost instantaneous rising of the skin.

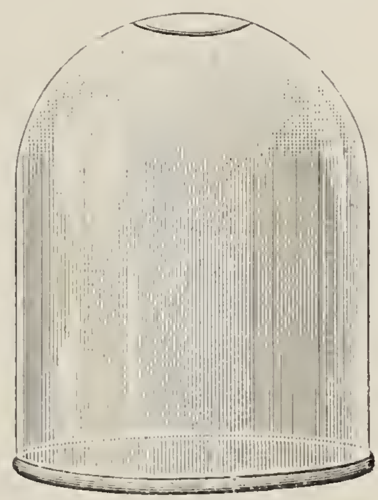


Fig. 171.—Cupping Glass.

The essential points to attend to are, that only just so much spirit should be put into the cup as will moisten its sides, and that the rim of the cup make perfect contact with the skin, so as to exclude all air. It is hardly necessary to mention that severe blistering may result from the edge of the cup being too hot, an accident not likely to occur if only a small quantity of spirit is placed in the glass.

In cases of suppression of urine, cupping over the renal regions is an extremely valuable form of treatment. (*See also* 'Bier Treatment,' p. 288.)

Leeches.—If leeches are to be applied anywhere within the cavity of the body, a leech-glass from which they cannot escape should be used ; but if they are required for outside surfaces, they may be placed within a pill-box, covered with a piece of lint, or held lightly in the hand. The part to be leeched should be washed with warm water, or milk, and must be perfectly clean. Those leeches should be chosen which are thinnest and most lively, and should be allowed to remain on until they drop off.

It is estimated that a leech should extract from 1 dr. to 2 dr. of blood before it is gorged, but if a fomentation be put over the bites, much more will flow.

A leech should never be allowed to bite into a vein, or troublesome hæmorrhage may follow ; pressure would always stop this, in any situation where it could be applied, but it may be necessary to adopt such measures as passing a needle below the bite, and twisting silk round it.

Blisters.—These are usually produced by painting blistering fluid

(liquor epispasticus B.P.) over the required area, or by applying a cantharides plaster, cut to the desired shape. If there are any hairs on the part to be blistered, they should be shaved off, and the skin washed with a strong soap, to remove the natural oil.

If the blistering fluid be used, the most convenient way to apply it is to cut a hole of the desired size in a piece of notepaper, to hold it firmly over the part, and then to paint on the fluid with a camel's-hair brush. In this way the blister is strictly limited. Another plan is to smear simple ointment round the part to be blistered.

The dresser or nurse must be careful to keep the hands well away from the eyes during the application of any blistering fluid.

When the bleb has fully formed, it may either be snipped at its most dependent part, and the serum soaked up with absorbent wool ; or if it be desired that the blister should remain open for some time, the whole cuticle should be cut off, and the sore dressed with some irritant ointment, of which the unguentum savinæ is the most frequently employed. (Blisters are occasionally dressed with mercurial ointment when a powerful counter-irritant is required.)

The active principle of cantharides being soluble in oil, the blister will be found to rise better and quicker if the surface of the skin where the plaster is to be placed is moistened with olive oil.

The Actual Cautery.—We have so frequently considered the employment of different forms of the actual cautery for various surgical purposes, that we need only here remind the reader of its employment for the arrest of hæmorrhage, the removal of growths, etc. Formerly it was extensively used as a counter-irritant, and whether the cautery irons or Paquelin's instrument were used, the usual method was to 'score' the skin surface over the seat of pain or disease, very much as a horse's leg is fired. But in the treatment of spinal disease by the various forms of thermo-cautery, other methods were adopted, such as the needle cautery, a description of which will be found in books especially dealing with this subject.

Vaccination.—The chief *plans* of vaccination are : (1) By means of tubes containing lymph from ripe vesicles ; (2) By means of tubes of calf lymph.

The chief *methods* of vaccination are : (1) By means of small oblique punctures into the cutis vera, made with an arrow-headed lancet, charged with the lymph, this being procured direct from the vesicle, or from a tube ; (2) By making numerous scratches through the cuticle within a small area, like the cross-hatching of an engraving, and then rubbing in the lymph from the vesicle, tube, or point, for a minute or two. This is the one most generally adopted at the present time.

In all cases, for a primary vaccination, at least four inoculations should be made, and the place nearly always chosen is the top of the arm, near the surface of the deltoid. Some mothers ask that their female children should be vaccinated on the leg, in order that the

scars may not be noticeable when a low dress is worn in later years ; there is no objection to this. We do not recommend vaccination on a nævus.

The lymph, which is enclosed in *capillary tubes*, is procured from ripe vesicles, the tubes being immediately sealed hermetically. Humanized lymph will, under these circumstances, keep for a long time. When it is to be used, the ends of the tube are broken off and the contents blown out upon a clean slip of glass. The vaccination may then be performed with a lancet, or by scratching with a needle as before.

The method which ensures the most satisfactory results is as follows : Having bared the arm, rub it firmly with a wet towel so that the skin becomes a bright pink colour. This brings the blood to the surface and removes the natural grease of the skin. Break open the tube at both ends and blow out a drop in as many places on the arm as inoculations are to be made. Then, placing the hand under the arm, the skin should be stretched slightly while the scratching with the needle is made through the drops of lymph. In this way the lymph is carried down to the bottom of the scratch and inoculation is rendered almost certain. The scratching should be done sufficiently deep to make only the merest drop of blood appear, though even this is said not to be necessary. The lymph must be allowed to dry on, and on no pretext whatever rubbed off or the arm washed during the next twenty-four hours.

Calf Lymph.—The methods of vaccination with *calf* lymph are precisely the same as with the humanized kind. It may be performed direct from calf to child, or by means of tubes.

It is absolutely necessary that all instruments used for the purposes of vaccination should be scrupulously clean.

The lymph at present recommended as the best is that known as glycerinated lymph. This is made by adding to one part of lymph four parts of sterilized 50 per cent solution of water in chemically pure glycerin. After storage for a month in some place protected from the light, this lymph is said to contain no pathogenic organisms, and to produce as good vesicles and afford protection as lasting and efficacious as any other lymph.

SECTION V

OF VENEREAL DISEASES

CHAPTER XXIX

SYPHILIS

By THOMAS ANWYL-DAVIES, M.D. (Lond.),

Director of the L.C.C. Venereal Centre at the London Hospital; late M.O. in charge, and late S.M.O. of the Venereal Clinic at St. Thomas's Hospital.

THE Diagnosis and Treatment of Venereal Diseases.—It is essential for casualty officers and house surgeons to have a general knowledge of the diagnosis and treatment of venereal cases, since they are a danger to the community, and their nature is such that efficient measures should be taken *as early as possible* to obtain successful results.

Medical officers are warned against a hasty declaration of venereal disease to the patient before the clinical evidence has been confirmed by positive pathological results, as such a diagnosis may lead to serious legal and domestic consequences, and proceedings may be taken against the medical officer for a mistaken diagnosis. Whenever possible this should be made *at once* by one of the various pathological processes to be described later. In the examination of a suspected subject, rubber gloves should be worn to avoid accidental infection. In adult cases the possibility of a 'mixed' infection should be considered, for the obvious signs and symptoms of one disease (e.g., gonorrhœa or chancroid) may mask the presence of a second (syphilis).

DIAGNOSIS.

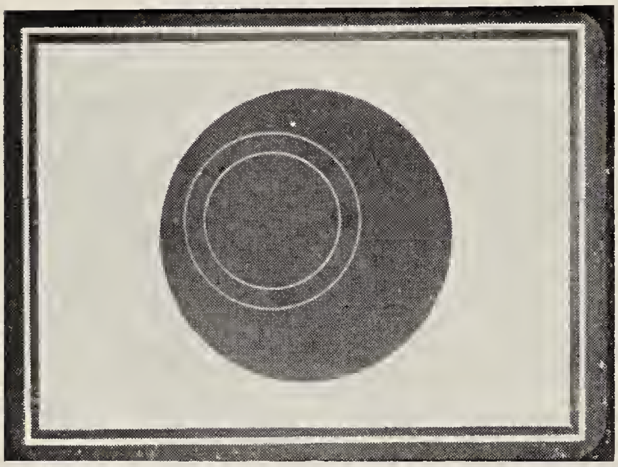
The presence of syphilis is diagnosed by: (1) The demonstration of the organism, *Spirochæta pallida*; or by (2) The positive reaction of the blood-serum or cerebrospinal fluid to the various complement-fixation and precipitation tests. The first method may be employed for lesions in the primary and secondary stages of the disease; but it is useless for tertiary manifestations, as in these cases *Sp. pallidæ* are so few that they are seldom demonstrable. A positive result given by the second method is considered by most authorities to indicate the presence of an active syphilitic focus somewhere in the body.

Demonstration of Sp. Pallida.—

Technique of the Dark-ground Examination.—*Sp. pallida* is demonstrated most easily by the dark-ground illumination method. For

PLATE V

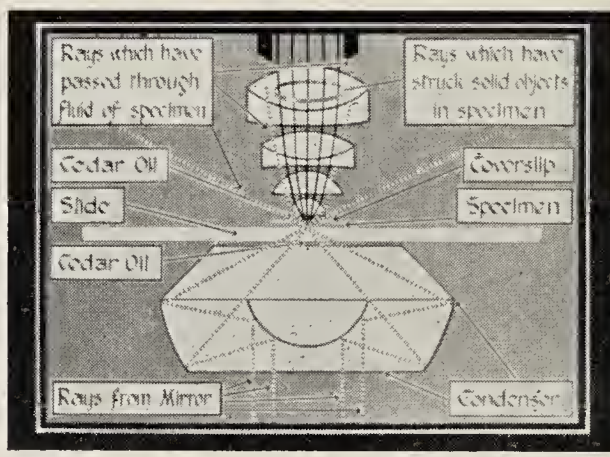
DARK-GROUND EXAMINATION FOR SP. PALLIDA



a

b

A.—Rings on the condenser viewed through $\frac{2}{3}$-in. objective. (*a*) Before, (*b*) After centring condenser.

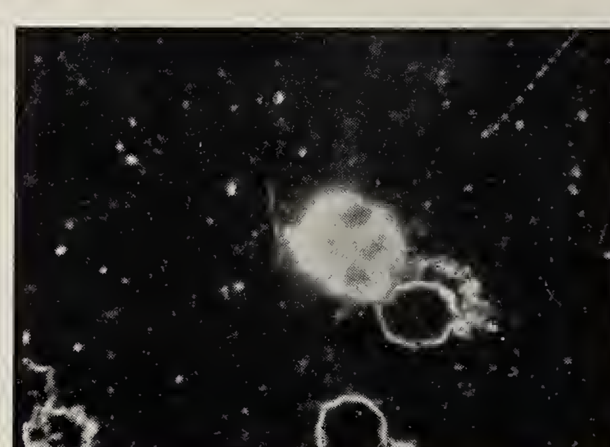


B.—Arrangement of slide and condenser.

a

b

c



d

C.—Stages in the adjustment of the mirror and the condenser. (*a*) Dark spot in patch of light. (*b*) Circular patch of light. (*c*) Spot of light (showing *Sp. pallida*). (*d*) Correct adjustment (showing two *Sp. pallida*).

this the specimen is prepared by scraping the lesion, squeezing out some of the fluid, gathering this on a coverslip held in Cornet forceps, dropping the coverslip on a slide of the thickness recommended by the maker of the special condenser used for this purpose, and making the specimen as thin as possible by pressing the slide, coverslip down, on filter paper.

A special dark-ground condenser is fitted in place of the ordinary substage lens, and if the objective is a $\frac{1}{12}$-in. oil immersion it is fitted with a funnel stop or an adjustable diaphragm made for the purpose. The illuminant, which should be fairly strong, is focused on the plane mirror of the microscope so as to fill it with light, and the top of the condenser is viewed through a $\frac{2}{3}$-in. objective. Two rings are seen, and by observing these the condenser is centred by means of adjusting screws (*Plate V, Fig. A*).

Immersion oil is dropped on the condenser and on the under side of the mounted specimen so that when the condenser and the slide are racked together the oil surfaces coalesce and the light rays pass through no air space between the condenser and the specimen (*Fig. B*). The oil on the condenser and the serum under the cover-glass should be as free from air-bubbles and dust as possible or the background may not be sufficiently darkened.

The mirror should be set so that a circular patch of light is seen in the centre of the microscope field. If there is a dark spot in the patch of light, it indicates that the condenser should be racked up or down until the dark spot vanishes.

Immersion oil is dropped on to the coverslip and the $\frac{1}{12}$-in. oil immersion lens is brought into focus in place of the low-power objective.

Appearance (*Fig. C*).—The organism of syphilis is one of the most delicate of the spirochætes. It is spiral in shape, with an average length of about 10μ, which is rather longer than the diameter of a red blood-corpuscle (7μ). The average number of spiral turns is about twelve. These are quite regular, and persist while the organism is at rest. It is motile and has a characteristic burrowing or rotary movement like a corkscrew, which is coupled with a slow waving or bending from side to side. *Sp. pallida* appears dead-white in colour against a dark background. Other spirochætes glisten, but *Sp. pallida* always maintains a characteristic dull-white appearance with a regular slow motility.

Staining Methods.—In *Noguchi's simple method* the secretion or tissue emulsion is mixed on the glass slide with a drop of the following solution (which keeps well for two or three weeks) :—

Formalin (40 per cent)		10 c.c.
Na_2HPO_4 (9·078 grm. per litre) ..	88 c.c.	90 c.c.
KH_2PO_4 (11·876 ,, ,, ,,) ..	12 c.c.	

The slide is prevented from drying by leaving it in a Petri dish

with a piece of damp filter paper for at least fifteen minutes. It is then dried and stained with Giemsa's solution, or saturated alcoholic solutions of gentian violet or carbol fuchsin. After pouring on the stain for half a minute, the film is washed in running water and then dried in air. With Giemsa's solution *Sp. pallida* has a pinkish-red colour, while the other spirochætes are stained with a bluish tinge. This method gives good results. It is simple and rapid, and is applicable to both tissue and serum emulsions.

Tribondeau's modification of Fontana's method is as follows :—

1. A thin film is spread on a slide and allowed to dry in the air.

2. It is fixed in Ruge's solution (glacial acetic acid 1 c.c. ; formalin 20 c.c. ; distilled water 100 c.c.) for 1 to 5 minutes.

3. The film is washed in running tap water.

4. The mordant solution (tannic acid 5 grm. ; carbolic acid 1 grm. ; distilled water 100 c.c.) is poured on and the slide is warmed until vapour has steamed off for 30 seconds.

5. The film is washed rapidly in tap water and flooded with a 5 per cent silver nitrate solution to which a few drops of ammonia have been added to make it turbid. If excess of ammonia is used, the precipitate redissolves and additional silver nitrate solution must be added until the turbidity reappears. The slide is heated till steam has risen for 30 seconds. It is then washed in tap water and dried. *Sp. pallidæ* appear dark brown or black on a yellowish background, and thicker than when stained by other methods.

The Wassermann Reaction.—The Wassermann reaction is founded on the well-known Bordet-Gengou phenomenon in which a mixture of an antigen and a serum containing antibodies to that antigen inactivates complement. In 1906, Wassermann, Neisser, and Bruck applied this 'Bordet-Gengou phenomenon' to syphilis, and discovered that if an extract of syphilitic liver (antigen) and guinea-pig's serum (complement) are added to the heated (to destroy the complement which is thermolabile) serum of a syphilitic person, the complement is fixed. This complement fixation did not occur with the serum of a non-syphilitic person. It has since been found that the syphilitic tissue extract can be replaced by alcoholic extract of normal organs.

The collection of the specimen from the patient is described on p. 304 under The Collection of Blood-serum. So many modifications of the Wassermann test are performed that it would be useless to describe the technical details here, as they vary considerably in different laboratories, but the broad outline of the test will be given.

Outline of the Test.—The patient's serum is heated at 55° C. for 30 minutes to destroy the complement in it, and a given dilution of an alcoholic extract of, say heart, and of fresh guinea-pig's serum (containing complement) are added. After a certain time, varying from half an hour to several hours according to the method employed, the mixture is tested for free complement by adding to it blood-cells sensitized with hæmolysin (this is the heated serum of an animal

which has received a number of injections of the same blood-cells). If the complement has been fixed (positive reaction), the cells are unaffected and the mixture remains turbid. If, on the other hand, the complement has not been fixed, the cells are lysed and the mixture becomes transparent (negative reaction).

Notation of Results.—To indicate the degree of reaction the usual method is to indicate strongly positive, positive, doubtful, and negative respectively by + +, +, ±, −.

Other Serum Tests for Syphilis.—There are other more recent tests for syphilis such as the Sigma, Kahn, Sachs-Georgi, and Meinicke, which vary considerably in technique and sensitivity. They depend on the degree of flocculation or precipitation which occurs when a syphilitic serum is incubated with a specially prepared extract of heart muscle. Usually they are more delicate than the Wassermann test in cases of treated syphilis, and it is a good thing to test a serum by both the Wassermann and one of the flocculation tests.

The Interpretation of Results.—Positive reactions have been reported by a number of workers with sera from patients suffering from quite a large variety of conditions, including yaws, leprosy, malaria, scarlet fever, and also pregnancy, but in most of them the evidence as to error in technique and the co-existence of latent syphilis has not been satisfactory. For practical purposes, if yaws is excluded, a positive reaction, especially when repeated on another specimen, indicates the presence of an active syphilitic focus with such a degree of probability that a diagnosis of syphilis must not be set aside except on very strong negative evidence. Yaws is due to a spirochæte, *Sp. pertenuis,* which is morphologically indistinguishable from *Sp. pallida,* and is moreover susceptible to the same forms of treatment.

A negative reaction, on the other hand, does not exclude syphilis. It is usual in the first two weeks of the disease and immediately after a course of treatment. Some persons never give a reaction though obviously suffering from active disease. Consequently a negative reaction is only a small piece of evidence which must be taken in conjunction with much other negative evidence before syphilis is excluded.

A doubtful reaction, sometimes called weakly positive, is only suspicious evidence. It never justifies the commencement of treatment in a hitherto undiagnosed case, but it may indicate the resumption of treatment. A doubtful reaction, especially in cases for diagnosis, should be repeated twenty-four hours after a provocative injection of arsenobenzene preparations, and the result confirmed by one of the flocculation tests.

In primary syphilis, 75 per cent of cases give a positive result during the second week after the appearance of the chancre ; in secondary syphilis and dementia paralytica, practically 100 per cent are positive ; latent syphilis, 64 to 80 per cent ; in the tertiary stage, 80 to 97 per cent ; and tabes, 70 to 90 per cent.

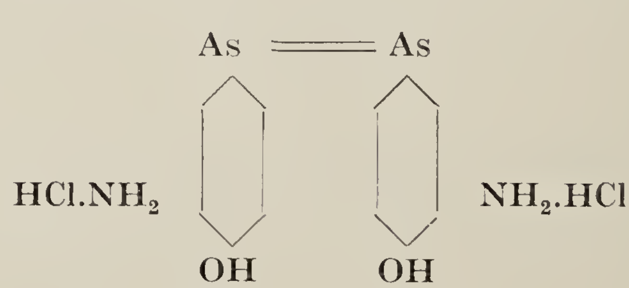
TREATMENT.

On account of their specific action, the drugs in general use against syphilis are preparations of the three metals, arsenic, mercury, and bismuth. Iodides are also given, as they stimulate the resolution of the granulomatous tissue which is the product of syphilitic infection. This granulomatous tissue often becomes fibrous and may prevent the access of the specific remedies to affected areas.

Mercury in its many forms, with the assistance of iodides, was the main treatment for syphilis until 1910, when the first results of treatment with Ehrlich's arsenical compound '606' were published. In 1922, Sazerac and Levaditi after many animal experiments demonstrated the antisyphilitic value of the tartrobismuthate of potassium and sodium, and since the first publication by Fournier and Guénot of its effect on human syphilis a very large number of bismuth preparations have been put on the market. Only those which personal experience has shown to be efficacious will be mentioned here.

Of all the above, the trivalent organic arsenical preparations have the quickest and most powerful spirochæticidal action, while metallic mercury and bismuth possess a less direct and a comparatively slower and milder therapeutic effect. Whether bismuth actually has a stronger action than mercury remains to be proved, but on account of its lower toxicity and easier administration it is more frequently used in venereal clinics than mercury. A more successful result is obtained and the Wassermann reaction becomes negative sooner when arsenobenzene preparations are administered simultaneously with bismuth or mercury than if these drugs are given separately in successive courses.

Arsenical Preparations.—The original *salvarsan*, known officially as *arsenobenzene* or as *arsphenamine*, and commonly as '606', is the dihydrochloride of dioxydiaminoarsenobenzol and has the following formula :—



It is a yellow powder soluble in water, the solution being strongly acid. It is suitable only for intravenous injection, for which it has to be neutralized with alkali and diluted to a strength of 0·1 grm. in 25 c.c. As the dose for an adult ranges from 0·2 to 0·6 grm., the quantity of solution injected is fairly considerable.

The reaction following an injection may be rather severe, and, to avoid these inconveniences, Ehrlich in 1912 devised *neosalvarsan* or '914', which is known officially as *neoarsenobenzene* or as *neoarsphena-*

mine, and is sold under the trade names of *neokharsivan*, *neosalvarsan*, *novarsenobillon*, and *novarsan*. Chemically it is dioxydiaminoarsenobenzene formaldehyde sulphoxylate of soda. Its arsenical content is 18 to 20 per cent, which compares with 27 to 30 per cent in '606', and the adult dose varies from 0·3 to 0·9 grm. On account of its ease of administration and lessened toxicity it is now more extensively used than any other arsenical preparation, although it is not therapeutically so active or so stable as '606'. It forms a neutral solution in water which is suitable for intravenous, intramuscular, or deep subcutaneous injection.

Another preparation more suitable than '914' for intramuscular or subcutaneous injection is dioxydiaminoarsenobenzene formaldehyde bisulphite of sodium, sold as *sulfarsénol*, *sulphostab*, *metarsenobillon*, or *myosalvarsan*, which usually causes little or no discomfort. Besides the advantage of convenience of administration, the bisulphite preparations probably have a more permanent therapeutic effect by reason of their longer retention in the body. The adult dose usually ranges from 0·2 to 0·6 grm.

Stabilarsan is a compound of one molecule of Ehrlich's original salvarsan base with two molecules of glucose in a solution of 50 per cent glucose ready for intramuscular or intravenous injection.

Silver-salvarsan is a combination of colloidal silver with sodium salvarsan, for intravenous use only, and is an attempt to increase the therapeutic activity of salvarsan by the addition of colloidal silver. This drug is said to penetrate more readily into nervous structures, and so is used preferably in tabetic and paretic cases. The dose is from 0·15 grm. to 0·3 grm. *Metarsenoargenticum* is a similar silver preparation which is suitable for intramuscular or subcutaneous use. The following pentavalent arsenical preparations are not used in the routine treatment of syphilis, but for special cases.

Tryparsamide (N-phenylglycinamide-*p*-arsonic acid) has a very weak spirochæticidal action, but penetrates more readily into the nervous system than do the trivalent preparations first mentioned. It is used in neurosyphilis, particularly tabes and dementia paralytica, and seems to act by increasing the resistance of the patient. Before administration an ophthalmological report should be obtained, as disturbances of vision and possible injury to the optic nerves may occur. The drug is dissolved in cold water and administered intravenously in a dose of from 1 to 3 grm. A course consists usually of 8 weekly doses of 2 to 3 grm. each.

Stovarsol, *spirocid*, or *orarsan* (acetyloxyaminophenylarsenic acid) were invented more particularly for the prevention of syphilis. When taken for this purpose the dose is usually 1·0 grm. (4 tablets) a day before breakfast for four days in two or three successive weeks. Opinions differ as to their value in prophylaxis. They are sometimes used as an adjuvant treatment when injections of other arsenicals cannot be given.

Bismuth Preparations.—Bismuth and its compounds have not such a powerful spirochæticidal action as arsenobenzene preparations (which are essential in treating cases of acute syphilitic infection), but they are particularly useful in conjunction with arsenobenzene and also when administered alone in late cases. Whether bismuth is as effective a therapeutic agent as mercury when this is skilfully administered is still an open question, but the convenience of the painless subcutaneous injection of an insoluble bismuth compound is the reason for its popularity. The establishment of a bismuth 'depôt' in the body seems to protect the host against the destructive action of *Sp. pallida.*

Bismuth preparations are innumerable, but as far as our present knowledge extends the most satisfactory for general use is an insoluble salt of bismuth, or metallic bismuth itself, suspended in an aqueous medium. Of the insoluble preparations suspended in water or in glucose solution, those in most frequent use are: bismuth hydroxide, bismuth oxychloride, bismuth salicylate, metallic bismuth, and sodium potassium bismuth tartrate.

Dosage.—Deep subcutaneous injections of a dose containing 0·2 to 0·3 grm. of bismuth are administered once or twice a week until signs of intolerance appear: usually a total of 2 to 4 grm. of bismuth can be given in a series of 10 to 12 injections before this occurs.

Mercurial Preparations.—These are suitably administered: (1) By inunction; (2) Intramuscularly; and (3) Orally.

1. *Inunction.*—Skilfully performed, this is the most effective means of giving mercury, but it is out of favour on account of its tediousness and inconvenience. Unguentum hydrargyri ʒj is rubbed daily into the body until it has been absorbed by the skin. This takes about twenty minutes. It is a mistake to rub the ointment into the hairy parts of the body such as the groins and axillæ, for a folliculitis is liable to occur in these situations. The ointment should be applied in turn to the back, the abdomen, and the limbs, and the same night-clothing should be worn over a period so that the ointment is also being absorbed during the night. A suitable method with infants is to put the ointment under the binder.

2. *Intramuscular Injection.*—Since bismuth has been employed this method has passed into disfavour on account of the intense pain that may result. Metallic mercury or 'grey oil' (gr. j weekly), calomel (gr. 0·3 weekly), mercury salicylate (gr. iss weekly) are made up into a cream suitable for intramuscular injection. Of these, calomel is the most active, but most likely to cause stomatitis and other toxic effects.

3. *Oral Administration.*—This method should not be used in early or acute syphilis, and is only suitable for travellers and those of advanced age who have already received more vigorous treatment.

Suitable preparations are: pil. hydrarg. c. creta gr. j t.d.s., pil. hydrarg. c. creta gr. j with pulv. ipecac. co. gr. j t.d.s. (Hutchinson's

pill), pil. hydrarg. iodid. virid. gr. $\frac{1}{3}$ t.d.s., and pil. hydrarg. iodid. flav. gr. $\frac{1}{8}$ t.d.s. Liquor hydrarg. perchlor. ʒj t.d.s. may be suitably combined in a mixture to be taken after meals, for all preparations of mercury given by mouth should be taken on a full stomach to prevent gastro-intestinal irritation and premature intolerance to the drug.

Iodine Preparations.—Iodides have no specific action on *Sp. pallida.* They are, however, particularly useful in the resolution of inflammatory and granulomatous tissue, and thereby possibly permit arsenobenzene, mercury, and bismuth to reach the affected tissues. It is possible also that iodine improves the metabolism, and so, besides increasing the resistance to syphilis, stimulates the tissues to make derivatives of injected metals (especially arsenical) which are essential for the destruction of *Sp. pallida.* Consequently they are given during the courses of injections of these drugs in every stage of syphilis, and especially large doses are given to patients with tertiary and gummatous manifestations.

Potassium iodide may be given in a dose from 5 to 60 gr. t.d.s., the drug being increased by 5 gr. per dose every four days until the coryzal signs of iodism arise. A useful mixture which contains tinct. nucis vom. to counteract the depressing effect of potassium iodide is the following :—

℞	Pot. Iod.	gr. v–lx.	Tinct. Nuc. Vom.	♏iij
	Pot. Bicarb.	gr. xx	Aq. Chlorof.	ad ℥j

t.d.s.

Potassium iodide is more effective than sodium iodide, which is sometimes tolerated when there is an idiosyncrasy to the potassium salt. This can also be overcome by taking the drug with black coffee, doubling the dose of the iodide, or adding liquor arsenicalis ♏ iv, to each dose.

Technical Methods.—

Intravenous Injections.—There are two ways of administering an intravenous injection. The first or gravity method, in which the solution is poured through a funnel or reservoir connected by a tube with a needle inserted into a vein, was in vogue when the large bulk of fluid of the original '606' had to be injected ; but this has been replaced by the syringe method, which on account of its simplicity and rapidity is now in general use.

A 5-c.c. or 10-c.c. all-glass syringe with a needle of 20 gauge is most suitable. These are sterilized by boiling or keeping in spirit, but immediately before use are washed thoroughly in distilled water. Cold freshly distilled water (3 c.c. to 10 c.c.) is placed in a sterile medicine glass which has been rinsed out previously with distilled water, and the contents of the ampoule are tipped into it. The drug is hastened into solution by keeping the nozzle of the syringe below the surface of the liquid and alternately filling and emptying the instrument until no solid particles remain. The solution should not

be aerated with bubbles from the syringe, as this increases its toxicity. It should be injected as soon as it is completely dissolved, or within ten minutes, for solutions of '914' deteriorate rapidly when exposed to the air. Before injection, the loaded syringe should be held vertically to the light to ascertain that the solution contains no residue or foreign bodies, and all air should be expelled from the syringe and needle.

The arm of the seated or recumbent patient is exposed, and the skin over the chosen vein in the antecubital fossa is sterilized with picric acid or tincture of iodine. To distend the vein a single band of rubber tubing is stretched once round the arm above the elbow, and tightened, not by twisting or knotting, but by holding the tubing between the finger and thumb, which are pressed against the arm. In this way the skin is not twisted on the arm and the tourniquet may be released by gently lifting the thumb. By this method, if a nurse is unavailable, the patient can assist by holding the tourniquet with the free hand. This is frequently a valuable psychological aid to a nervous patient, whose attention is diverted to the performance of the task. To assist the veins into prominence at the elbow the arm and forearm are held straight, while the wrist is flexed and some object such as a roll of bandage is clenched in the hand. In order to slant the arm the patient is told to keep the shoulder up and the wrist down. If it is still difficult to detect the vein, the patient is told to release the object in the hand and with the tourniquet in place to relax the forearm and wrist. The rotation and bending of the flaccid elbow-joint *by the operator*, whilst feeling for the vein, will generally reveal its position. It is sufficient to be able to feel the vein even if it cannot be seen ; but if these measures do not suffice to locate it, the arm may be soaked in hot water for ten minutes before the injection, or the skin over the vein may be slapped with the palm of the hand.

Success depends largely on the ability of the practitioner to gauge accurately the *depth*, fixation, and calibre of the blood-vessel beneath the examining thumb or finger *before* the needle enters the skin. The skin below the site of the puncture should be steadied by grasping the forearm so that the skin may not move before the needle point. The operator should concentrate his gaze on the site of the puncture as intensely as possible.

The syringe should be held between the right thumb and first finger, or between the thumb and the second finger with the first finger pointing along the syringe, with the short bevel of the needle uppermost, and the practitioner should stand so that he is able comfortably to direct the needle and syringe in the same straight line and along the course of the vein, just over it and parallel with the skin, until the point of the needle is dipped to pierce the skin and enter the vein. When the needle is in the lumen of the vein a jet of blood forces back the piston, which is then slowly pushed forward

by the thumb after the tourniquet has been released. Before the injection of the least drop of the solution it must be ascertained beyond doubt that the needle is safely and freely in the lumen of the vein, and that none of the solution will escape into the tissues around. If it is suspected that the piston is stiff or stuck it should be rotated and pulled backwards, which will draw blood into the syringe if the needle is in the correct position. When the injection is completed, a plug of cotton-wool is pressed on the site of the injection, while at the same time the needle is pulled rapidly away. Then the patient is told to flex the elbow with the wool still pressed on the puncture, to open the hand, and to keep the forearm raised for a few minutes.

Intramuscular Injections.—An all-glass syringe of 2 to 5 c.c. capacity is used, with needles of 20 or 22 gauge and about 2 in. long. The ampoule is opened, and if the contents are in powder form, it is filled with the dissolving solution—freshly distilled water, 50 per cent glucose (which in this concentration acts as an anæsthetic), novocain, or any of the numerous solvents on the market. The sterile syringe and needle, after having been washed free of alcohol or any other antiseptic with distilled water, are filled with the preparation by aspirating it directly from the ampoule. By this method contamination of the drug is prevented and it is ready for injection in the minimum of time. The addition of a local anæsthetizing agent such as novocain is unnecessary except in very nervous subjects, for with intramuscular and deep subcutaneous injections of antisyphilitic remedies pain is not severe until several hours after the injection, and by that time the effect of a local anæsthetic has disappeared.

The injection should be made into the inner part of the upper and outer quadrant of the buttock, which is marked by a horizontal imaginary line level with the upper end of the gluteal cleft and a vertical line midway between the great trochanter and the mid-line. Separating the needle from the syringe and holding it between the thumb and forefinger, it should be stabbed with a rapid movement of the wrist into the glutei, causing it to enter the tissues at right angles to the skin. The empty needle should be directed slightly inwards, for then it is not so liable, especially in thin people, to hit bone and leave its point in the periosteum. The depth to which the needle is inserted—usually from three-quarters of its length up to the hilt—can be gauged only by practice. The buttocks should be palpated beforehand to ascertain the best position for inserting the needle and the force requisite to drive the needle to the desired depth. The syringe is now fitted on to the needle, and the piston pulled on to see if any blood enters the syringe and to make sure that the needle has not tapped a blood-vessel. Care should be taken that the needle is kept stationary while it is in the tissues and while the piston is being pushed down. The needle and syringe are then withdrawn as one, as rapidly as possible to prevent any

solution remaining along the track of the needle. The buttock is now massaged gently, and the patient is told to repeat this night and morning for several days.

If the needle touches bone, if blood oozes from it, or if the patient complains of intense pain down the leg, it must be withdrawn and inserted elsewhere. If the injection is skilfully administered, there is no pain at the time, and the insertion of the needle is not felt. This result depends chiefly on obtaining absolute relaxation of the buttock and the absence of involuntary twitching as the needle enters the tissues. To obtain this relaxation the weight of the patient should be supported by a couch or table so that the legs can hang loosely with the toes turned inwards. Some patients prefer to remain half-standing but with the body resting on the table, while others find it easier to recline face downwards at full length along the table with arms hanging down on each side and the toes pointing inwards.

Deep Subcutaneous Injections.—The technique in this case is exactly the same as the procedure for intramuscular therapy except that, instead of inserting the needle at right angles to the skin, the subcutaneous tissues are pinched up from the fascia covering the muscle by the thumb and first finger of the left hand, and the needle is made to enter the side of the hillock thus formed in a slanting direction at an angle close to the skin. The point of the needle is not allowed to pierce the muscle ; with practice one learns that the needle has reached the fascia covering the muscle by the increased resistance, and by the needle being more freely movable from side to side when it is lying in the loose tissue over the fascia. The object of a deep subcutaneous injection is to place those drugs which are suitable for this method on to the fascia covering the muscle and so avoid the possible pain or tenderness caused by the contraction of a muscle which is slightly inflamed by the drug. Therapeutically there is practically no difference between the intramuscular and the deep subcutaneous methods, for in both cases the drug begins to act within thirty seconds and a continual gradual absorption of a small amount of the drug occurs over a period of about ten days. This explains the superior results obtained by these methods over the intravenous route, where the drug circulates in the blood for about three hours only and most of it is eliminated within twelve hours.

The Collection of Blood-serum.—At least 5 c.c. of blood should be taken, for, although only 1 c.c. is required for the Wassermann test, an extra supply of serum may be required for confirmatory tests. It may be obtained by pricking the lobe of the ear or the thumb and aspirating the blood into a pipette, but it is simpler and quicker to puncture a vein with a needle, or, if the vein is of small calibre and in a difficult position, to aspirate it with a needle and syringe.

The skin over the suitable vein in the antecubital fossa of the recumbent or seated patient is sterilized and the veins are distended by stretching a single band of rubber tubing once round the arm

above the elbow and asking the patient to clench the fist. The tubing is tightened by the nurse or the patient holding it between the finger and thumb. In this way the skin is not twisted and the tourniquet can be released by gently lifting the thumb from the tubing without disturbing the relative positions of the vein and needle.

The needle may be attached to a syringe, or have a small piece of rubber tubing attached to its base by which the blood can be conducted into a test-tube. The needle is inserted bevel uppermost while a finger of the other hand steadies the skin distal to the puncture so that it will not move under the pressure of the needle point. (For further details, *see under* Intravenous Injections, p. 301.)

The needle, syringe, and the test-tube to which the blood is transferred should be dry, sterile, and free from spirit or water. Contamination of the specimen with alcohol or water may upset the reaction and bring about discoloration of the blood-serum by causing a certain amount of hæmolysis. This can be avoided by sterilizing and drying the apparatus or washing it with isotonic saline solution.

As the needle is withdrawn a cotton-wool swab is placed over the skin puncture and the arm is held vertically for a few minutes to stop the hæmorrhage.

Courses of Injections.—These are many and varied, but clinicians agree that the injections should be interrupted, on account of the cumulative toxic action of the drugs employed. Many change the brand with alternate courses, as *Sp. pallida* may become resistant to one particular preparation.

The following specimen course adopted by Colonel Harrison at St. Thomas's Hospital has produced satisfactory results :—

Week	Arsenobenzene Compound	Bi	or Hg
	Grm.	Grm.	Gr.
1 (Blood test)	0·45	0·4	1
2	0·45	0·4	1
3	0·45	0·4	1
4	Rest	Rest	Rest
5	0·6	0·4	1
6	0·6	0·4	1
7	Rest	Rest	Rest
8	0·6	0·4	1
9	0·6	0·4	1
10	Rest (KI gr. v t.d.s.)	Rest	Rest
11	Rest (KI gr. x t.d.s.)	Rest	Rest
12	Rest (KI gr. xv t.d.s.)	Rest	Rest
13	0·75	0·4	1
14	0·75	0·4	1
15	0·75	0·4	1
16 (Blood test)	Interval for 2 months		

A satisfactory course should contain at least 5 grm. of '914' (or its equivalent if another preparation is used) together with 3 grm. of

bismuth or 8 gr. of mercury administered within three months. At least three such courses should be given to the average patient irrespective of the stage of syphilis, the interval between each course varying from six to eight weeks, a blood test being taken after the completion of each course.

Toxic Effects of Arsenobenzene Compounds.—The arsenobenzene preparations cannot be administered in a haphazard manner on account of the damage they may cause to capillary epithelium, bone marrow, and the liver cells. They are contra-indicated in hæmophilia, Addison's disease, and advanced visceral disease. When given to cases of diabetes mellitus the blood-sugar should be watched.

The immediate toxic effects are of the nature of vasomotor disturbances, such as flushing of the face, a feeling of constriction about the neck, dilatation of the pupils, and a rapid pulse. In a more severe case the face, neck, and tongue may become swollen and the patient may complain of dyspnœa and precordial pain. These symptoms are relieved by a hypodermic injection of 0·5 c.c. adrenalin (1–1000), by venesection, and if necessary by cardiac stimulants such as strychnine and camphor. They can often be prevented in future injections by giving the remedy in a more dilute form, or more slowly, or by keeping the tourniquet on during the injection.

On the day of the injection the patient may suffer from rigors, pyrexia, headache, diarrhœa, vomiting, and urticaria. Later complications are epileptiform convulsions, fainting attacks with cyanosis, and unconsciousness. These cases should be treated with adrenalin, venesection, and the removal of 15 to 20 c.c. of cerebrospinal fluid by lumbar puncture.

More remote ill effects which may occur at any time after the injection are erythema, dermatitis, and jaundice.

Erythema may be treated by daily intravenous or deep subcutaneous injections of 25 c.c. of a sterilized solution of glucose 25 per cent (neutralized with 2 to 5 c.c. of 4 per cent NaOH solution in 250 c.c.) to which has been added 0·45 to 0·6 grm. of sodium thiosulphate, which is an antidote for any metallic poisoning.

Exfoliative dermatitis is treated in the same way. Alkalis and aperients, an abundance of bland fluids and carbohydrates, with a fat-free diet, are prescribed, while the skin is kept dry by applications of calamine liniment and magnesium carbonate, zinc, and starch powder. The easily removable scales of skin are peeled off by hand, and cracks or fissures at the flexures may be painted with an aqueous solution of 1 per cent picric acid or eusol. An occasional bran bath assists the removal of dead skin, but is liable to exhaust the patient, and the drier the skin the less is the likelihood of septicæmia intervening. Painful crusts and cracks on the face are relieved by olive oil or paraffin oil, and sepsis of the eye-sockets is prevented by regular boracic eye-baths.

Jaundice is treated by injections of sodium thiosulphate in glucose

as above, by a similar fat-free diet, and the exhibition of alkaline mixtures, copious bland fluids, and aperients.

Precautions in the Administration of Arsenical Preparations.—

1. Do not starve the patient beforehand; there is less fear of damage to the liver and subsequent arsenical jaundice if the liver cells contain their normal content of glycogen. Two hours' fasting is sufficient.

2. With the view of increasing the glycogen content of the liver, before each arsenical injection administer by mouth the following:—

℞ Glucose	ʒxiv	Ol. Limonis	♏j
Sod. Bicarb.	gr. xv	Aquam	ad ℥iij

This treatment appears to increase the resistance of the liver cells to the toxic arsenobenzene preparations.

3. Before each injection, the urine should be examined for albumin. Albuminuria is a contra-indication (except in acute secondary syphilis, which is a frequent cause of albuminuria).

4. Examine the skin for signs of intolerance to arsenic such as an erythema, dermatitis, jaundice, seborrhœa, or eczema.

5. Make sure that the ampoule is not faulty and that the contents are normal in appearance.

6. The syringes and dissolving solutions must be cold, otherwise the preparation may become oxidized and considerably more toxic.

7. Any alcohol, methylated spirit, or antiseptic used to sterilize the syringes and needles must be removed by repeated washings with distilled water.

Precautions in the Administration of Bismuth and Mercurial Preparations.—

1. Examine the urine to exclude albuminuria.

2. Exclude stomatitis. Bismuth causes a blue line round the edge of the gums. This is a valuable sign, as it is a guide to the amount of bismuth and the dosage that can be tolerated. When the blue line is seen the administration of bismuth need not be stopped (unless stomatitis is actually present), but the dose should be reduced. Oral cleanliness should be insisted on so that as much bismuth or mercury can be administered as possible before stomatitis intervenes.

3. Take the weight to see that the patient is not unduly depressed.

Tests of Cure.—Finality on this subject has not been reached, but no case can be considered cured until the Wassermann reaction of the blood serum has been consistently negative taken every three months during a period of at least two years after the cessation of treatment. The last test should be preceded by a provocative injection and accompanied by tests on the cerebrospinal fluid, which should be examined at the end of the first year after the suspension of treatment, and again at the end of four or five years. Patients who have an inveterate Wassermann reaction in spite of prolonged treatment should remain under observation for many years.

CHAPTER XXX

GONORRHŒA

ALTHOUGH records of gonorrhœa date back to antiquity, at present the ingenuity of man has failed to discover a cure similar to the specific action of salvarsan on syphilis. Gonorrhœa is one of the commonest causes of blindness. Therefore the patient should be warned against contamination of the eyes with the discharge, and concerning the danger and proper disposal of infected clothes, towels, and bedding.

DIAGNOSIS.

Gonorrhœa is diagnosed by : (1) The demonstration of the gonococcus (*a*) by staining methods, or (*b*) by culture, or preferably both ; or by (2) A positive reaction of the blood serum to a complement-fixation test with a gonococcal antigen. No secretion or discharge should be diagnosed as gonorrhœal until the gonococcus has been demonstrated by pathological methods, since no positive diagnosis can be made solely from the clinical appearances of the discharge.

The Demonstration of the Gonococcus.—

Appearance.—The gonococcus was discovered by Neisser in 1879. It is a small Gram-negative diplococcus which appears like two kidney-shaped beans placed side by side with their adjacent surfaces slightly concave. In acute gonorrhœal discharges these organisms are found embedded in the protoplasm of polynuclear leucocytes. Gonococci also occur extracellularly, particularly in films from chronic cases. Caution must be taken in diagnosing extracellular organisms as gonococci, especially in preparations from the female genitalia, in which innumerable organisms are found.

Staining Methods.—Every film for diagnosis should be stained by Gram's differential method, but for demonstration purposes Löffler's methylene blue, carbol fuchsin, and thionin blue are all suitable. Jensen's modification of Gram's method is reliable and easy. It is carried out as follows :—

1. Collect the discharge on a platinum loop, make a thin film, and fix it by passing the slide three times through the flame. If it is overheated, distorted appearances occur which render the preparation useless.
2. Let the slide cool.
3. Stain with 0·5 per cent aqueous methyl violet for half a minute.
4. Wash with iodine 1 part, potassium iodide 2 parts, distilled water 100, for half a minute.

5. Wash away with absolute alcohol. Add fresh alcohol until the stain ceases to diffuse from the film into the alcohol. This decolorization should not take more than one minute: with continued washing the Gram-positive organisms may become decolorized.

6. Counterstain with neutral red solution (neutral red 2 grm., 1 per cent glacial acetic acid 2 c.c., distilled water 1000 c.c.) for half a minute.

7. Dry the slide with filter paper, and examine.

During the entire process no water should be allowed on the slide.

Gonococci do not stain with methyl violet (which thus acts as a differential stain for Gram-positive organisms such as staphylococci, streptococci, pneumococci, and diphtheroids), but absorb the counterstain and so appear a pinkish-red colour. Other counterstains are Bismark brown or safranin.

Cultures.—Legally only the cultural growth of the gonococcus is accepted as proof of the presence of gonorrhœa, as the staining methods have many limitations. Stains do not differentiate between the gonococcus and certain other Gram-negative diplococci; and some Gram-positive cocci, for various reasons, occasionally stain as Gram-negative organisms.

The gonococcus is easy to culture when: (1) The warmed culture tube is taken from the incubator, inoculated while warm, and immediately returned into the incubator regulated to the correct temperature of 37° C.; and (2) The correct culture medium is used. A very successful medium is a disodium-hydrogen-phosphate agar slope with peptone added, titrated to pH 7·5, and enriched with human serum, ascitic, or hydrocele fluid.

The Gonococcal Fixation Test.—A positive reaction of the blood serum to a complement-fixation test with a gonococcal antigen is usually strong evidence of a gonococcal infection, and in the absence of clinical or bacteriological signs calls for further stringent examination of the patient. As in the case of the Wassermann test, a negative reaction is of no value in excluding gonorrhœa, and a positive is of little value after the administration of gonococcal vaccine. The test should always be applied in cases of suspected gonorrhœa in females when other bacteriological evidence is lacking.

A positive result can be obtained as early as the first week, but in the majority of cases the result becomes positive during the third week. Experience shows that if the test is strongly positive, the diagnosis is usually confirmed by obtaining the gonococcus, provided a sufficient number of smears and cultures are taken.

No patient should be discharged as cured unless the gonococcal fixation test is negative.

TREATMENT IN THE MALE.

The Acute Stage.—The patient should be told to drink as much fluid—such as water, mineral waters, and tea—as possible, so that

the bladder is emptied frequently and the discharge in the urethra is washed away—every hour of the day if possible. Any form of alcohol, coffee, quinine tonic water, condiments, asparagus, cucumber, strawberries, and watercress are forbidden.

The aim of treatment should be to raise the patient's resistance by all possible means and to attack the local infection by drainage—the keynote of surgical measures. Aperients should be given freely, as constipation is a feature of gonorrhœa. Rest in bed for the first week will shorten the attack ; but if this is not possible, the patient should be told to walk as little as possible and to recline on every suitable occasion with the legs resting upon a couch or chair. Frequent hip baths and soaking the penis in hot water will assist in reducing the local inflammation and congestion. No exercise should be taken during the acute stage—horse-riding, dancing, and motor-cycling are dangerous, and even the vibration of a motor car, however luxurious it may be, is a distinct promoter of complications. Recent researches have shown that vitamin A in comparatively large doses increases the resistance of the body against any infection and also assists diseased tissues to be replaced by fresh healthy tissue. An efficient and concentrated form is radiostoleum, which has been found by the writer of great value in the treatment of gonorrhœa when it is given in large doses—2 drachms once daily over a period of several weeks. Other useful vitamin preparations are radiomalt, vitamalt, and essogen.

Autogenous gonococcal *vaccines* may be disappointing, but a stock polyvalent gonococcal vaccine, mixed if necessary with the secondary organisms found in the urethra, is of value. The usual procedure is to give a course of six or eight injections, every five or seven days, with an initial dose of 5000 millions, raised by 50 per cent increments to a maximum of 80,000 millions. If a detoxicated vaccine is used, the dosage is from 1000 millions at first, up to 5000 millions. The dosage is not increased if the reaction, either locally or constitutionally, is too severe. Each case must be treated on its own merits and the dose varied accordingly.

The most efficient method of draining the urethra is by the normal act of micturition. In addition *irrigation* should be performed by the patient himself two or three times daily with a warm solution of potassium permanganate. At first the strength should be 1–10,000 to 1–8000, but as the inflammation subsides and the patient becomes accustomed to the procedure it should be raised to 1–6000 and ultimately to 1–4000. No benefit is obtained at any stage if this concentration is exceeded.

A Janet blunt-ended nozzle is used, attached by rubber tubing to a reservoir (glass, enamel, or rubber bag) (*Fig.* 172), which is hung level with the patient's forehead, whether he is standing or sitting, so that the pressure in the urethra is not more than four feet. The bladder is emptied and the nozzle is inserted into the urethra loosely

so that the solution is able to escape freely round the end of the nozzle. In this way the anterior urethra only is irrigated. Then the nozzle is pressed tightly into the urethral orifice so that no fluid can escape, and the full pressure from the reservoir is exerted. At the same time the urethral sphincter is relaxed and the bladder becomes filled with the irrigating solution. This is voided as soon as the bladder feels uncomfortable.

Some patients may find difficulty in relaxing and allowing the

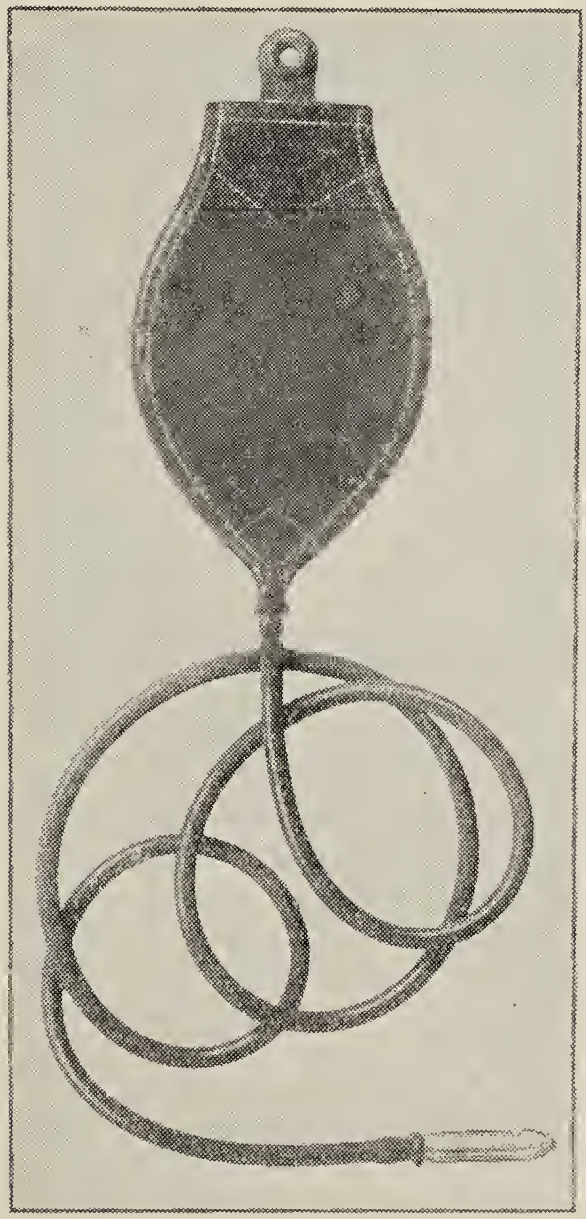


Fig. 172.—Irrigating Apparatus.

solution to enter the bladder, but this may be overcome if it is at the correct temperature (about 100° F.). The temperature varies with each individual patient, and can be found only by trial. The procedure is facilitated if the sphincter is opened by a slight attempt to micturate against the pressure of the solution while at the same time the patient relaxes the muscles by inhaling deeply.

Sometimes a hand syringe used by the patient is employed for local treatment. It is a method attended by grave disadvantages,

being a fruitful cause of secondary infection and of complications following posterior urethritis. The patient is asked to carry out on himself an operation for which he has no training, and usually he does it very badly, forcing the infection into the posterior urethra. Further, hand syringing is useless in posterior urethritis. Irrigation of the whole urethra, on the other hand, keeps the posterior urethra well washed with an antiseptic which prevents the gonococcus from gaining a foothold there. Statistics confirm this. The idea that bladder irrigations will " push the infection back " is a myth.

Gonorrhœal bags which slip over the penis and are tied round the waist by tapes may be obtained to catch the discharge, but they are not so convenient as a handkerchief attached by two safety-pins to the back of the shirt and allowed to hang down behind it like an apron. The handkerchief tucked round the penis and scrotum allows free drainage of the discharge, and prevents contamination of the clothing, and can be readily washed by the patient. If he drinks a satisfactory amount of fluid, very little discharge should collect on the handkerchief.

Drugs.—The gonococcus autolyses in alkaline solutions. Hence the following prescription may be useful :—

℞	Pot. Cit.	gr. xxxv	Sod. Bicarb.	gr. xx
	Tinct. Hyoscyam.	♏x	Aq. Chlorof.	ad ℥ss

t.d.s.

The potassium citrate acts as an alkaline diuretic, and the tincture of hyoscyamus is a sedative which allays dysuria and prevents painful erections. Although sandalwood-oil capsules are widely used, they have no specific action and may cause backache and indigestion. They are useful only to relieve painful micturition in the acute stage, and may be prescribed for this purpose for two or three days. Urotropine is frequently exhibited, but in the acute stage the liberated formaldehyde acts as an irritant to the tissues ; at the same time it is not in sufficient concentration to kill the gonococcus, and therefore should not be prescribed.

Innumerable *irrigating solutions* have been used, but in the acute stage, in the writer's experience, hot potassium permanganate, 1–8000, provides the best results. As an alkaline solution autolyses the gonococcus and dissolves mucus, sodium bicarbonate, 1–5000, may be added to the above permanganate solution immediately before use. If, however, the fluid is too warm, sodium carbonate is formed, and this may act as a caustic irritant to the urethra or make potassium manganate if left too long in contact. After micturition and immediately before irrigation, the writer has obtained excellent results by injecting 2 to 3 c.c. of pure glycerin gently into the urethra and holding it there for several minutes. The glycerin has a powerful solvent effect on the gonococcus, is painless, and its hygroscopic action assists drainage from the follicles and folds of the urethral mucous membrane. As concentrated solutions of potassium permanganate and glycerin

in certain proportions form an explosive mixture, it may be advisable after using a glycerin injection to irrigate with some solution other than permanganate. Other solutions employed are: acriflavine 1–5000 to 1–1000, mercurochrome 1 per cent, neocargon 2·5 per cent, argyrol 1–1000, protargol 1–1000, albargin 1–5000, lunosol 1–1000, zinc permanganate 1–8000, oxycyanide of mercury 1–5000, and silver nitrate 1–10,000.

Commoner Complications of the Acute Stage.—

Peri-urethral Abscess.—If drainage in the urethra is unsatisfactory, the ducts may become blocked and cause a peri-urethral abscess. This commonly occurs in the perineum or at the fossa navicularis: a tender indurated swelling appears, which at first may be mistaken for an intrameatal chancre. The abscess rapidly enlarges, fluctuates, becomes acutely painful, and may cause rigors and retention of urine. It may burst through the skin or into the urethra; the latter is desirable, but the former may result in a troublesome urinary fistula.

When fluctuation is not present and the abscess is small, it should be incised and drained into the urethra with the cautery of the operating urethroscope (*see* URETHROSCOPY, p. 315).

If, however, the swelling is large and fluctuating, it should not be incised through the skin, but aspirated with a stout needle and syringe. Before the needle is removed, the cavity may be washed out with electrargol, proflavine (0·1 per cent), or tincture of iodine diluted with water to 1–20, and some of the solution left behind. Aspiration may be necessary for several days in succession, and should be combined with hot hip baths and hot fomentations to relieve the pain and œdema. When this method has been adopted, as soon as the inflammation has subsided, drainage into the urethra should be assisted by the cautery through the urethroscopic tube and by regular dilatation of the urethra with instruments. If this is not done at a future date, the urethra may be reinfected from this focus and a stricture may form.

Acute Prostatitis and Vesiculitis.—The prostate is infected in practically all patients with a posterior urethritis. In acute cases the prostatic lobes are enlarged, tender, and boggy. If the vesicles are involved, they are palpable and have a similar feeling. A prostatic abscess may develop and cause pyrexia, painful micturition, and defæcation, with intense pain in the perineum and back. If retention of urine occurs and hot baths fail to relieve it, a soft rubber catheter may be passed. The patient should be put to bed and urethral irrigations stopped until the acuteness subsides. Iodine and morphia suppositories, aperients, hot hip baths, and hot rectal douches may be prescribed, while very gentle prostatic message at the proper time may assist drainage into the urethra.

Acute Epididymitis.—Alcohol, sexual activities, and exercise during the acute urethritis may spread the infection along the vas deferens to the epididymis. At first the lower part (globus minor) becomes

tender and enlarged, and the patient complains of a dragging, heavy feeling in the scrotum and along the course of the spermatic cord. Later the whole epididymis and sometimes the testicle may be involved. The discharge lessens, and as it does so, the epididymis becomes tense, more swollen, and painful ; indeed, the pain can become so intense that the patient may be unable to stand or walk. Vomiting and a temperature of 102° to 104° F. are not uncommon.

Rest in bed, strong purges, light diet, and copious fluids are essential. Urethral irrigations should be stopped and the scrotum supported by a pillow or suspensory bandage. Glycerin and belladonna, lead and opium lotion, hot baths, and hot fomentations (these are generally more effective than ice or cold evaporating lotions) help to diminish the pain, but the most satisfactory method of applying heat is by diathermy. Intravenous injections of electrargol (1 to 10 c.c.) daily in increasing doses, or neosalvarsan every two or three days, are valuable in relieving pain and assisting resolution.

The Subacute Stage.—After about two weeks, when the urethral discharge has ceased, the urine loses its turbidity and becomes clear but remains full of pus-threads. At this stage, but not before the urine is clear, *the urethra and its ducts should be dilated* once or twice weekly by the passage of straight metal sounds or a Kollmann's

Fig. 173.—Kollmann's Dilator.

straight anterior dilator (*Fig.* 173). This dilates the mouth of the ducts, stretches infiltrated areas, increases the flow of blood, and so aids drainage and the more efficient action of the subsequent hot irrigations.

Vaccines are more useful at this stage, and many practitioners wait until the acute stage is over before commencing them.

The Chronic Stage.—In spite of the previous treatment, the discharge may not entirely disappear, but be intermittent and cause a stickiness or closure of the urethral orifice in the morning. It is now essential to determine accurately whether the focus of infection is in the anterior or posterior urethra, and if in the posterior urethra whether the prostate and vesicles are infected.

Diagnosis of Posterior Infection.—A rough test is *Thompson's two-glass test* : The patient is asked to urinate into two glasses, emptying one half of the bladder into the first and the rest into the second. If pus and turbidity are confined to the first glass, then the anterior urethra is assumed to be infected and the posterior urethra has escaped. If, however, both glasses are turbid or contain threads, the whole urethra is infected. This test is insufficient for accurate diagnosis, as a slight posterior discharge may be washed into the

first glass ; and as success depends on accurate localization of the remaining foci, a more elaborate technique is necessary.

When the patient has held his urine for a number of hours, preferably overnight, wash out the anterior urethra thoroughly with a clear antiseptic lotion such as mercury oxycyanide 1–5000, or with sterile tap water if cultures are desired. Then let him pass his urine into a number of glasses. If this urine is clear and free from threads, it is probable that the posterior urethra is not infected, but before coming to a final decision on this point the prostate and vesicles should be examined after irrigating the urethra and leaving some of the clear lotion in the bladder.

Examination of the Prostate and Vesicles.—The patient is placed in the knee-elbow position or told to recline across a couch with the toes turned inwards. The gloved first finger is inserted into the rectum and stretched upwards and outwards to feel the top of each vesicle. If they are palpable, the contents are gently emptied by pressing the finger downwards and towards the mid-line. Some practitioners experience difficulty in feeling above the vesicle, but an extra reach of one to two inches can be obtained by pulling the buttocks aside with the free hand. This hand can also be pressed into the perineum or above the pubes to bring the prostate into closer contact with the examining finger in the rectum. Both lobes of the prostate are emptied by gentle massage for two or three minutes by stroking the finger from without downwards and inwards towards the mid-line. A specimen of the prostatic secretion may be collected from the urinary meatus by a platinum loop and smeared for examination, after which the contents of the bladder are voided. This specimen contains the prostatic and vesicular secretions, and its centrifugalized deposit should be examined if insufficient evidence is obtained from the prostatic bead.

Treatment of Chronic Anterior Urethritis.—If the posterior urethra, prostate, and vesicles are free from infection, acorn-tipped bougies and the urethroscope should be employed to ascertain the cause and site of the chronic anterior urethritis.

Acorn-tipped bougies are useful in localizing an inflamed area, opening and emptying inflamed follicles, and detecting an obstruction in the urethra. When the head of the bougie slides over a patch of soft infiltration, the urethra is felt to be roughened and tender. If there is a distinct obstruction as the instrument is withdrawn, a hard infiltration has formed for which gentle dilatation with a Kollmann's dilator or solid sounds is necessary. The aim in dilatation should be to stretch the urethra gently and avoid overstretching. With a Kollmann's dilator one advances one or two degrees at each sitting, which takes place about every five days.

Urethroscopy.—The urethroscope is invaluable as it enables the practitioner by direct vision to ascertain the exact condition of the urethra. From this an accurate diagnosis can be made, treatment

can be applied directly to any particular spot, its effect noted, and the return to normal of the urethral mucous membrane can be confirmed visually.

Of the various types of urethroscope, the most suitable have provision for distending the urethral folds by air. The illuminant may be at the base of the instrument or situated at the distal end of the cannula, and housed so that it does not obstruct the field of view or any operative procedures.

The modern urethroscope of the type in which the illuminant is at the distal end of the cannula (Col. L. W. Harrison's model—*Fig.* 174) consists of a cannula, D, with a lamp-stem in a special tube, N, so that the light shines across the field but does not dazzle the observer's

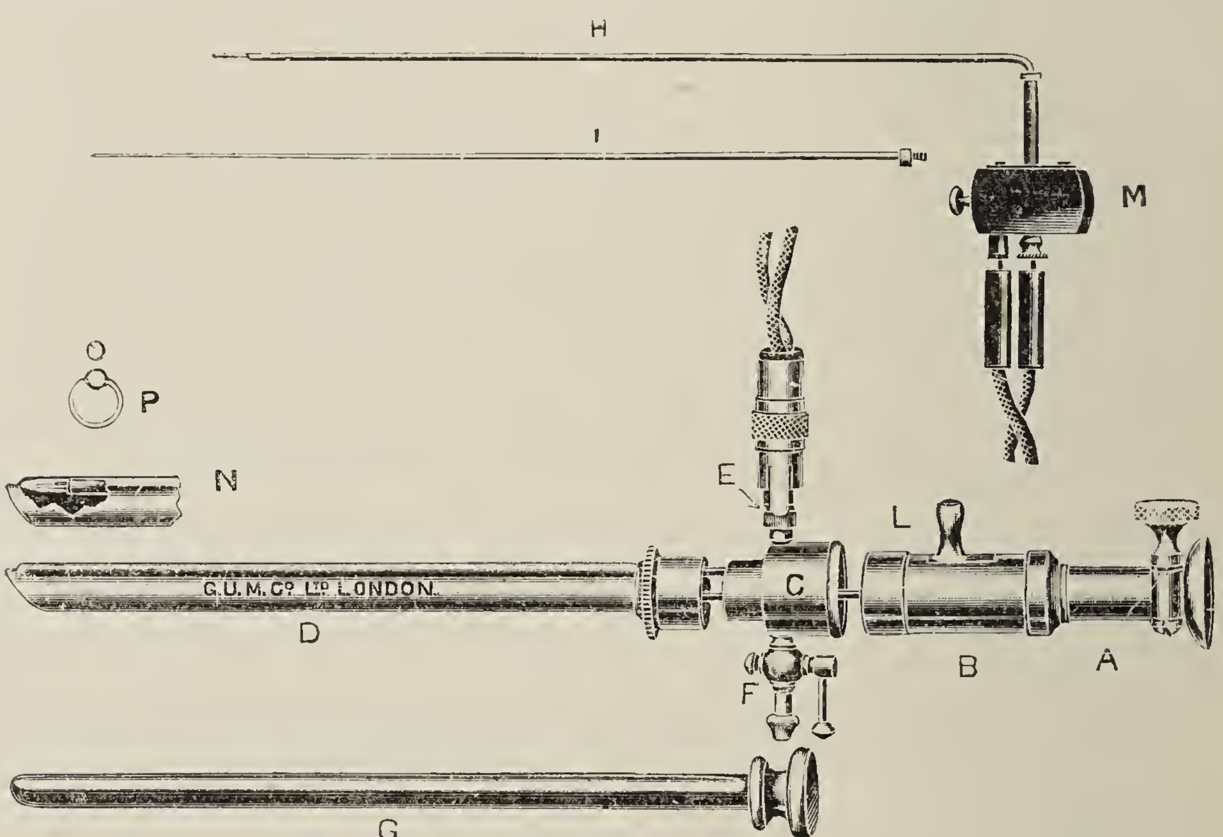


Fig. 174.—Colonel Harrison's Urethroscope.

eye. After removal of the obturator, G, the lamp attached to C is passed along the side-tube, shown in cross-section at O P. C has on one side the electrical switch, E, and on the other the bellows attachment, F. If any operative procedure is required, it is done through B, which has a movable handle, L, into which the operating probe, I, or the cautery, H, can be screwed.

Before the patient has urinated and disturbed the pathological picture in the urethra, the lubricated cannula with the obturator in position is passed into the canal as far as it will go (a local anæsthetic such as 2 per cent or 4 per cent novocain can be injected beforehand, but this is seldom necessary), the obturator is removed, and a sterile wool swab on a probe is inserted down the cannula to remove the excess of moisture in the urethra. If this is not done, fluid is liable

to well up into the cannula and obstruct the view. The lamp with bellows attachment is then inserted into the cannula, and the patient under the direction of the observer works the bellows, the operator manipulating the tap F so that the urethra is alternately collapsed and distended but not overstretched. The cannula is then gradually withdrawn so that the whole of the anterior urethra is inspected from behind forwards. Both the normal urethra and its pathological conditions vary so much in appearance that it is impossible to detail them here, and only by constant practice can proficiency be attained.

By alternately distending and collapsing the urethral wall, abnormalities in its elasticity, the formation of hard and soft infiltrations, peri-urethral abscesses, and the presence of strictures can be observed. By noting the surface and colour of the mucous membrane, infiltrations, erosive and granular patches, ulcerations (possibly syphilitic), leucoplakia, papillomata, varicosities, and littritis can be detected.

Various conditions can be dealt with by the operating attachments. Infected Littré's ducts and glands, as observed by their pouting red orifices and the pus exuding from them, can be destroyed by cautery or caustic silver nitrate on the end of the probe. This should not be done until the mucous membrane of the urethra generally has regained its normal appearance, for the raw surface left is a suitable nidus for re-infection from other parts of the canal, and premature operative procedures may make the condition worse. Peri-urethral abscesses and strictures may be incised with a cautery. Serum for dark-ground observation may be scraped from an intrameatal chancre by attaching a ring curette. Leucoplakia, which is usually the result of over-treatment, and varicosities should be left untouched.

Treatment of Chronic Posterior Urethritis.—If the posterior urethra, prostate, or vesicles are involved, the prognosis is not so satisfactory and treatment may be long and laborious.

Chronic Prostatitis and Vesiculitis.—In chronic cases the prostate may feel hard with irregular craggy nodules, or generally enlarged, boggy, and painful. Prostatic, and if necessary vesicular, massage—as previously described—should be performed twice weekly for about six weeks, with the introduction once weekly of a metal sound. During this period every means should be employed to raise the patient's immunity.

Prostatic massage empties the lobes and ducts of bacteria and inflammatory products, increases the blood-supply through and round the gland, and auto-inoculates the patient with vaccine manufactured in his own tissues from the living organisms. The prostate should be massaged after filling the bladder with an antiseptic lotion such as mercury oxycyanide, so that the contents of the gland are expelled directly into a bactericidal medium. After a course of massage, bacteriological tests should be taken. These should be repeated after a rest interval of three or four weeks, and followed if necessary by alternate courses of treatment and rest for several months.

In certain cases it may be desirable to treat the posterior urethra after the acute stage of prostatitis has subsided with antiseptic solutions through an Ultzmann's syringe (*Fig.* 175), dilatation with the posterior Kollmann's dilator, or the posterior urethroscope, but these methods are not advisable as a routine.

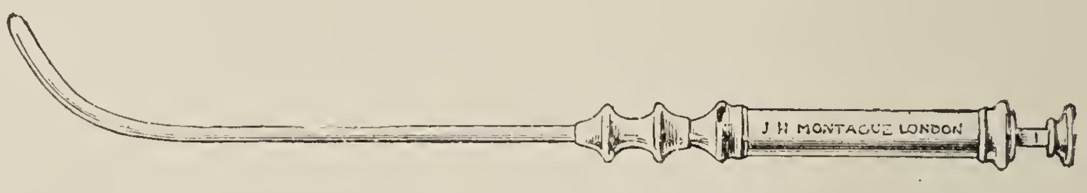


Fig. 175.—Ultzmann's Urethral Syringe.

Epididymitis.—This complication following posterior urethritis may be caused by excessive exercise during the acute stage, too vigorous massage of the prostate, an unsuitable dose of gonococcal vaccine, rough instrumentation of the posterior urethra, bladder irrigations under too high a pressure, or the use of an unduly irritant solution. It should be treated by rest in bed, suspension of irrigations, purges, hot fomentations, and the application of soothing lotions such as glycerin and belladonna or lead and opium to the scrotum, which should be supported day and night in a suspensory bandage. Pain may be relieved and resolution aided by diathermy, and by injections of neosalvarsan or electrargol (1 to 10 c.c.) intravenously every two or three days.

Metastatic Complications.—It is useless to treat the metastatic complications without attacking the main focus of infection from which absorption is taking place. Hence treatment of the genito-urinary area should always coincide with the local treatment of the part concerned.

Protein shock therapy by the injection of T.A.B. vaccine, electrargol, or milk, etc., is commonly employed, and usually results in a rapid subsidence of symptoms. My own impression, based on careful observation of many patients treated by this method, is that it may result in prolonging the duration of the disease, as the gonococcus seems to persist in the genito-urinary passages longer than in cases treated by antipyretics and analgesics coupled with the usual routine treatment of the original focus of infection.

Tests of Cure in the Male.—Each case should be decided on its own merits, for one negative set of tests may be sometimes altogether inadequate. The patient should satisfy the following conditions before treatment is suspended preparatory to tests of cure :—

1. Absence of discharge, with no local or metastatic symptoms.
2. Absence of abnormalities on palpation of urethra. Cowper's glands, prostate, and vesicles.
3. Absence of pus in urine for one week.
4. The passage of an acorn bougie followed by a metal sound should

produce no pus and reveal no obstruction or infiltration of the urethral wall.

5. Urethroscopic examination should reveal no lesion such as a soft or hard infiltration, infected follicle, or stricture along the urethral canal.

6. Microscopic examination of the bead resulting from massage of the prostate and vesicles should reveal no pus or gonococci. At least two smears should be thoroughly searched, as gonococci are generally few in a prostatic bead and a cursory examination is useless. A culture from the prostatic bead after the meatus has been carefully cleaned should be negative also.

In every case (6) should be carried out, even if no symptoms of a posterior infection have been noticed. If, however, the patient is considered to have had only a simple anterior urethritis, it will be sufficient if (6) is performed once only unless pus cells are found in the prostatic smear.

7. Before the application of final tests the treatment should have been suspended for at least a week, during which the patient should resume normal life (except sexual intercourse), taking condiments, coffee, and alcohol, including beer. All these must cease immediately on the slightest suspicion of the return of symptoms. It is a good plan to provide the patient with microscope slides so that he can make specimens of any discharge seen on rising in the morning.

8. A provocative injection of 200 millions of a polyvalent gonococcal vaccine should not provoke a return of symptoms. If a discharge occurs, it should be examined for organisms and pus cells.

9. The urethra should be fully dilated with a Kollmann dilator.

If the patient has had a definite prostatitis, vesiculitis, epididymitis, or any metastatic complications such as rheumatism, arthritis, or tenosynovitis, the vesicles and prostate should be massaged early in the morning before micturition has occurred, the patient having been instructed to drink beer on the previous evening. Smears and cultures should be taken from the resulting bead, and the centrifuged deposit from the urine passed after the massage should be examined for gonococci and pus cells. This should be repeated two or three times.

If the above are satisfactory, the patient should be told to return in three months for a repetition of the tests, including the complement-fixation test, taken both before and ten days after a provocative prostatic massage.

TREATMENT IN THE FEMALE.

The behaviour and treatment of female gonorrhœa differ from that of the male on account of the difference in anatomical and histological structure. The simple antiseptic douche promotes cleanliness but has little curative value, for after the acute symptoms subside, the gonococcus persists in the urethra, Bartholin's ducts and glands, the cervical glands, and the muscular wall of the uterus : places which

are hardly affected by douching. The first two sites of infection are easily dealt with, but to eradicate the organisms from the cervix and uterus is far more difficult.

The old school of thought believed in applying caustic antiseptics such as silver nitrate, liquor potassæ, iodized phenol, picric acid, formalin, etc., on a probe, and painting the cervix and its canal as a routine. Some ten years ago the writer, in collaboration with the late Professor Shattock, by a series of experiments found that these drugs form a dense layer of necrotic débris and dead epithelium which inhibit drainage, retard leucocytosis, and behind which the gonococcus and other pyogenic organisms thrive and multiply, and spread deeper into the tissues. Unfortunately no antiseptic applied to the epithelium of the uterus or the cervical canal has sufficient penetrating power to destroy the more deeply placed organisms.

The gonococcus enters the blood-stream in practically every case, and in 50 per cent of cases at least, when the infection is first contracted, or during the acute stage, it passes the internal os and reaches the uterine cavity, where its presence is recognized by the tenderness and bogginess of the uterus. In the majority of cases this causes no serious symptoms until the infection reaches the Fallopian tubes, a catarrhal condition of which occurs in at least 25 per cent of cases. Thanks, however, to the more modern treatment, of which the key-note is free drainage, the cases of salpingitis which require operation are now less than 1 per cent.

The Acute Stage.—In all stages the general measures previously described for raising the resistance of the male should be employed in the female also.

In addition, during the acute stage, rest in bed, especially just before, during, and after menstruation, diminishes the liability of the disease to spread to the Fallopian tubes and beyond, and hastens the time of recovery.

Hot hip baths containing mild antiseptics such as weak lysol, milton, chloramine-T, and boracic acid allay irritation, remove the discharge, and assist the circulation in the genitalia.

Copious hot vaginal douches, although they do not adequately cleanse the posterior fornix, etc., are valuable because they reduce the congestion of the tissues and remove superfluous discharge, and so assist the patient's comfort. Only weak solutions should be employed, as strong solutions lower the vitality of the tissue cells and help the invading organisms to obtain suitable foothold. Many drugs are used for this : lysol, milton, potassium permanganate, acriflavine, flavine, monsol, listerine, and chloramine-T. That most suitable, and apparently of more value than potassium permanganate so extensively used in the male, is chloramine-T in a saline solution :—

℞	Chloramine-T.	1 oz.	Water	to 24 oz.
	Sodium Chloride	1 oz.		

Of this stock solution, ½ oz. is added to 1 pint of hot water.

In addition to the above, the following procedure with the patient in the lithotomy position has provided the most satisfactory results at St. Thomas's Hospital Venereal Department.

1. The urethra is irrigated through a glass catheter with a warm saturated solution of sodium bicarbonate. This alkaline solution dissolves the superficial discharge and gonococci, and enables the second irrigating fluid (the saline chloramine-T solution) to act more efficiently.

2. A Ferguson's or Cussco's speculum is inserted into the vagina and the cervical canal is washed out through a backflow irrigator with the same two solutions.

3. The surplus moisture in the vagina and vaginal fornices is removed by cotton-wool swabs. If considered advisable, probes of non-caustic solutions such as hydrogen peroxide, glycerin, or mercurochrome-220 can be inserted into the cervical canal.

4. The vagina is packed with 1 yard of gauze folded longitudinally on itself three times and soaked in glycerin of borax 10 per cent during the first week, glycerin of ichthyol 5 per cent during the second week, and glycerin with monsol 5 per cent during the third week. The hygroscopic properties of the glycerin attract the tissue fluids from the cervical glands and the uterine cavity, and so help to empty these tissues of gonococci. The patients should be advised to wear a towel after treatment to avoid damage to clothing.

In very acute cases the above procedure can be carried out twice daily with advantage, but in mild cases and during the subacute and chronic stages it should be performed once daily, the gauze drain being left in position and changed every twenty-four hours. After it has been removed, a good vaginal douche should be given before treatment is repeated.

Pregnant women and acute cases of salpingitis are treated in the same manner, except that instrumentation of the cervical canal and insertion of a gauze drain are omitted. The vagina and cervix are swabbed out daily with hygroscopic solutions such as glycerin and ichthyol 5 per cent, glycerin and monsol 5 per cent, or formalin (1–300) in glucose 50 per cent.

By this method of drainage practically all the discharge disappears in about three weeks, and in those subacute and chronic cases where backache and nausea have occurred these distressing symptoms depart after a few days. Tampons and plugs of cotton-wool containing glycerin and other medicaments are not advised, because they become saturated with discharge which remains in the vagina and makes the cervix sodden and unhealthy.

In cases of metastatic gonorrhœa, and where the uterus and Fallopian tubes are involved, the drainage treatment is reinforced by Remington Hobbs's method of inserting an open-ended rubber catheter (No. 3 or 4 English) into the uterus without dilatation or by the use of a volsellum, as it is important to avoid any trauma.

Pure glycerin (2 or 3 c.c.) is gently syringed into the uterine cavity through the catheter, which is then withdrawn. If the catheter, instead of being gently coaxed, is forced through the internal os, or if the uterus is filled with too much glycerin under pressure, the patient is liable to collapse through shock. With ordinary care this should not occur. Hobbs's original method was to leave the catheter in the uterus for six hours and to add iodine to the glycerin, but better results are obtained with the more recent procedure described above. It can be repeated as frequently as necessary. It has a more marked and lasting effect than protein-shock therapy, and if adopted more often might reduce the necessity of laparotomy for salpingitis to a negligible percentage.

The Chronic Stage.—In these difficult cases it may be necessary to apply several modes of attack before a cure is obtained.

The drainage methods previously described are entirely suitable, with the additional application of the writer's pancreatic ferment (pancreatin 20, glycerin 50, water to 100), which readily dissolves tough cervical mucus and is preferable to the commonly used but intensely caustic liquor potassæ. The ferment solution should be applied on a probe into the cervical canal before the gauze drain is inserted.

Bucura, of Vienna, claims good results from the application of a suction glass to the cervix. This draws out the plug of mucus, and medicaments such as iodine may be inserted into the cervical canal, which is then massaged on an acorn sound. If this fails, he exposes the canal to the internal os by a lateral incision, and makes a series of closely-set punctures with the fine cautery to a depth of $\frac{3}{4}$ cm., but leaving intact mucous membrane between each puncture. The incision is repaired later by suture.

The injection of mercurochrome-220 (1 per cent) weekly into the cervix is sometimes successful. A needle of fine gauge (20) is inserted for $\frac{3}{4}$ to 1 in. into the cervical tissue parallel to and half an inch from the canal. Around this six or eight punctures are made and the solution is injected along the track of the needle as it is withdrawn. With care, pain and sloughing do not result.

At St. Thomas's Hospital satisfactory results have been obtained with chronic patients who are unable to attend frequently by supplying them with a pessary, to be used nightly, of the following composition: monsol 5 per cent, kaolin 15 per cent, glycerin 56 per cent, gelatin 11·2 per cent, water 12·8 per cent. This pessary was supplied by the pharmacists to provide a solid cone containing the maximum quantity of glycerin and a minimum of water.

In spite of statements that diathermy will cure female gonorrhœa, this method of treatment, although suitable for certain septic cases in which the gonococcus is not present, is passing into disfavour as far as gonorrhœa is concerned. Unfortunately the writer's results, checked by careful pathological tests, are unfavourable, and many

reports from Continental and American countries are also unsatisfactory. No increase of temperature of the tissues in one area will destroy the gonococcus. Moreover there is always an adjacent zone of optimum temperature for the organism in which it multiplies and spreads freely when this treatment is adopted. Hence a deeper penetration follows and treatment is prolonged.

Complications.—

The pruritic forms of vulvitis and vaginitis in long-standing cases with multiple re-infections associated with other gynæcological conditions may cause much inconvenience and severely tax the practitioner's resources.

Strips of lint, 3 in. long, soaked in carbolic acid (1–40 or stronger), which is both analgesic and antiseptic, should be inserted into the vagina for one inch and the rest spread fanwise over the labia. The strips are kept in position and the vulva is powdered by a pad of boracic wool fastened by a T bandage. This, after being applied two or three times, preferably at night, should be followed by a lotion such as phenol ♏xxx, liquor carbonis detergens ♏xlv, calamine gr. lxxx, zinc oxide gr. lxxx, glycerin ʒij, water to ʒiv; or a lanoline ointment with bismuth carbonate (gr. x to ℥j) and glycerin. Other applications, such as silver nitrate 20 per cent in spiritus ætheris nitrosi, cocaine 4 per cent, and salicylic acid ½ per cent, are all useful.

After the condition has subsided, dusting powders insufflated into the vagina and on to the vulva soothe the mucous membrane and absorb any irritating secretion. Such are boracic acid and starch in equal parts, fuller's earth, bismuth subgallate, aristol, chinosol, dichloramine-T, and kaolin.

Bartholinitis should be treated by sitz baths and hot fomentations, and the abscess aspirated through the mucous membrane on the inner side of the labia. The pus removed should be replaced by electrargol and proflavine 0·1 per cent at alternate aspirations. These may be necessary twice daily for the first two days, but after that once daily should be sufficient. By this method a cure is effected within a week, and experience shows that recurrences seldom happen.

The abscess may be incised and the cavity packed daily with medicated gauze, but this is a painful proceeding which causes a slowly granulating wound that takes several weeks to heal and frequently leaves a deformity of the vulva.

Arthritis, tenosynovitis, and *gonorrhœal rheumatism* may be intensely painful. The pain should be relieved by absolute rest of the affected part, and local applications such as lead and opium lotion, glycerin and belladonna, antiphlogistine, and ichthyol. Immediate relief is given to a distended joint by aspiration of the fluid after the skin has been carefully sterilized.

To obtain satisfactory results and prevent a recurrence the original focus of infection must be treated at the same time. Massage with passive movements should be instituted as soon as possible. In

gonococcal affections prolonged splintage and immobilization is a mistake, as adhesions, contractions, and ankylosis are liable to occur.

Tests of Cure in the Female.—During the treatment bacteriological tests should be taken after each menstruation and before treatment is resumed. The tests should consist of a smear and culture from both the urethra and the cervical canal, and from the Bartholinian ducts if they have been involved. Thus a survey of the patient's condition and progress as governed by the series of the four results obtained after each period, noting the presence or absence of gonococci and the amount of pus in the smears, may be consulted at any time. It is a mistake to discharge a patient on one negative set of tests or on a routine number of negative smears and cultures. No case should be discharged until there is a complete absence of clinical signs and symptoms, at least three complete consecutive sets of negative results (consideration being paid to the actual amount of pus in the smears in relation to the quantity of the other organisms present, apart from the absence of the gonococcus), and a negative gonococcal fixation reaction.

CHAPTER XXXI

THE DRESSING OF VENEREAL LESIONS

THE **Syphilitic Chancre.** — To excise, apply caustics to, or cauterize the syphilitic chancre will not stop the progress of the disease, for *Sp. pallida* has passed along the lymphatics before the initial lesion develops. The appropriate injections of antisyphilitic remedies will, however, cause the chancre to heal within a few days. During this time the writer has obtained satisfactory results from dressings of glycerin and boracic lotion. The lesion may not heal as rapidly as with lotio rubra or unguentum diamido-azo-toluol, but possibly with the longer drainage a recurrent chancre is not so liable to form and any later manifestations of syphilis may not be so severe. Unguentum hydrargyri and lotio hydrargyri nigra are useful, but if liquor hydrargyri perchloridi is applied, a dilution of 1–1000 or less should be employed. By the use of a greater concentration *Sp. pallida* is protected by the formation of an albuminous coagulum; this disadvantage does not apply to the biniodide of mercury (1–1000), which is a most efficient antiseptic.

If a chancre is hidden behind a tight prepuce and there is any suspicion of phagedæna, a dorsal slit should be made through the prepuce to obtain drainage. If it is very septic, *phagedænic*, or malignantly gangrenous, and accompanied perhaps by œdema, balanitis, or severe vulvitis, antiseptic baths of hot potassium permanganate (1–6000), hot boric acid, or chloramine-T to the parts several times a day should be given, with dressings of chlorinated soda lotion. These dressings should be stopped as soon as the ulceration is clean, as chlorine destroys the growing epithelial cells. If the lesion is particularly large and septic and the patient is ill and toxic, the septic absorption and the pain may be stopped by the application of camphenol, a mixture of pure carbolic and camphor in equal parts. Hydrogen peroxide, monsol, acriflavine, chloramine-T, eusol, and picric acid 1 per cent in aqueous solution, are also suitable.

When the sloughs have been removed and the wound is clean, healing is promoted by a glycerin, alum, and zinc lotion such as the following :—

℞	Zinc. Sulphatis	gr. x	Glycerini	℥ vij
	Alum. Purif.	gr. xx	Aquam	ad Oj

This prevents the gauze dressing sticking to the freshly formed epithelial tissue.

Syphilitic Condylomata.—Syphilitic condylomata on the scrotum, vulva, perineum, and round the anus, which frequently become septic, can be treated with eusol, chloramine-T, lotio sodæ chlorinatæ, or mercury biniodide (1–1000) for the first twenty-four hours, and then with more soothing dressings such as glycerin and ichthyol (5 per cent), glycerin thymol co., or calamine lotion. They disappear in a few days after the injection of an arsenobenzene preparation.

Gummatous Ulcers.—Gummatous ulceration tends to heal rapidly after a few injections of an arsenobenzene compound and bismuth accompanied by potassium iodide by mouth. Occasionally a gummatous ulcer on the leg, especially when accompanied by varicose veins, is difficult to heal unless the limb is at absolute rest and the leg raised to assist the venous return.

If the ulceration is septic and tends to slough, it may be cleansed in a few days by hot fomentations of chlorinated soda or eusol. The skin around is protected by vaseline, zinc and benzoin ointment, or olive oil 3 parts with methylated spirit 1 part. When the surface of the ulcer looks clean and healthy it may be dressed with red lotion (lotio rubra : zinc sulphate gr. ij, tinct. lavandulæ co. ♏x, water ad ℥j) or black lotion (lotio nigra : 15 gr. of calomel to 5 oz. of lime water). Both these lotions should be applied by a saturated piece of lint cut to the size and shape of the floor of the ulcer, so that their action is confined to that area alone. At this stage alternate dressings of hydrogen peroxide and eusol also give satisfactory results, while chloramine-T (2 per cent) and friar's balsam (tinct. benzoin co.) freely diluted are useful. The occasional insufflation of powdered charcoal or iodoform assists in keeping the lesion clean and absorbing the discharge.

If the patient cannot rest, the application of an Unna's bandage hastens recovery by supporting the tissues and preventing swelling of the limb ; but this method cannot be used when the discharge is copious. The ulcer is carefully cleansed with eusol or hydrogen peroxide and covered with sterilized gauze while the leg is elevated. A gauze bandage is then wound smoothly, without 'reversing', round the leg from the ankle to the tubercle of the tibia. Unna's paste (zinc oxide 5 parts, gelatin 5 parts, boric acid 1 part, glycerin 8 parts, water 6 parts) is melted in a water-bath or glue-pot, and when sufficiently cool is painted with a brush over the whole of the bandage. A second bandage is applied and painted over in the same manner, and, if a firmer support is necessary, a third or fourth layer may be used, and the whole is protected by the usual calico bandage. Generally this Unna's dressing is renewed once a week or fortnightly, but if the discharge is profuse it may need changing every other day, or at any time if it causes pain. Removal is readily accomplished with a pair of stout scissors.

The last stage of healing may be assisted by stimulating ointments such as scarlet red, diamido-azo-toluol ('pellidol'), ichthyol, or pro-

flavine oleate, and dusting powders such as aristol or di-chloramine-T. To ensure rapid healing all these local applications should be accompanied by the simultaneous administration of an arsenobenzene preparation, bismuth, and iodides in increasingly large doses.

Chancroid.—Formerly known as soft chancre, which is caused by Ducrey's bacillus. Chancroid is frequently of an intractable nature, and may take several weeks to heal unless rest and free drainage are obtained. With these lesions strong solutions or cauterization must be avoided. There is no doubt that mild measures ensure the best results.

Colonel Harrison recommends the use of eusol applied by gauze which is kept continuously moistened, while the writer has obtained excellent results by alternate dressings of eusol, pure glycerin, and formalin (1–300) in glucose 50 per cent, with frequent applications of ultra-violet rays. Cole recommends exposure to a large electric light bulb under a tent for several hours a day. This is reasonable, because the organisms of chancroid grow best in a moist medium shut off from the air.

Vaccine therapy has been employed considerably on the Continent, following the investigations of Rivalier with a soluble antigen, the rabbit experiments of Nicolau and Banciu, and the use of a specific vaccine by Reilly. This method has not been generally adopted in this country, as the cases here are fewer and appear to be less severe.

The bubo which usually accompanies chancroid should be aspirated as soon as it has formed, the fluid being replaced by electrargol and, at alternate punctures, by proflavine 0·1 per cent, which has the advantage that it does not coagulate albumin. During the first two or three days aspiration may be necessary twice daily, but after this once daily is sufficient. The condition usually resolves at the end of a week. Peyton has observed that the use of dusting powders on the ulcers (probably by preventing efficient drainage) accelerates and accentuates the inflammatory bubo.

Papillomata.—Papillomata on the genitalia may be caused by an irritating discharge, gonorrhœal or otherwise. They occur frequently on the perineum and round the posterior commissure of pregnant women whose vaginal secretions are abnormally abundant.

In the majority of cases the papillomata will disappear with the cessation of the discharge. If they are of the large coxcomb or cauliflower variety, they may be removed from the vulva by diathermy or X rays, and from the prepuce by circumcision, by ligation, or by the regular application of Mill's wart paint :—

℞	Liq. Arsenicalis	1	Spt. Vin. Rect.	2
	Vin. Ipecac.	1		

Balanitis.—Simple balanitis recovers rapidly with soakings and irrigations under the prepuce of peroxide of hydrogen, mercury biniodide (1–1000), or eusol, followed by packing with gauze dipped

in acriflavine 1 per cent, proflavine 0·1 per cent, glycerin thymol co., or glycerinum iodi. After the discharge has ceased, a dusting powder such as di-chloramine-T or zinc oxide and boric acid in equal parts should be used for several weeks.

If the balanitis is accompanied by secondary infection, œdema of the prepuce with lymphangitis and cellulitis of the penis, and perhaps phagedæna, the prepuce should be slit down the dorsum to obtain free drainage.

SECTION VI

OF CASES REQUIRING PROLONGED OR MECHANICAL TREATMENT

CHAPTER XXXII

OF HIP DISEASE

THERE are certain surgical cases in which deformity is a prominent feature, which are so common, and require such patient and prolonged treatment, that every student of surgery should understand the principles of their mechanical and general management.

The most important of these are the usual forms of *Hip Disease*, of *Lateral* and *Angular Spinal Curvature*, of *Club-foot*, *Contracted Knee*, and *Bandy Leg*.

In describing, as we propose to do in this section, the ordinary proceedings for the treatment of these conditions, we shall confine ourselves to the manual operations, and shall not discuss their pathology or treatment in other respects.

I.—ACUTE HIP DISEASE.

In all the acute forms of hip disease the surgeon's efforts are directed towards subduing the inflammation so that suppuration shall not occur, and towards preventing deformity If these ends are to be obtained, the joint must be *kept at rest*, and the limb *kept in extension*.

The muscles about the hip are the chief agents in keeping up irritation and causing the deformity of *flexion* and *abduction*, and it is because muscular spasm can be better controlled by steady traction than by any other means, that the use of the stirrup and weight is so general in these cases ; for although the plan was first introduced with the idea that an actual separation of the inflamed joint surfaces was thus obtained, it is now generally held that this does not occur.

The most **Common Plan of Treatment** is to put the patient to bed in the supine position, with the head low ; with a stirrup and weight attached to the limb, and passing over a pulley (*Fig.* 176) ; and with the foot of the bed raised, as described for fractures of the femur, under which heading the method of putting on the stirrup and weight will be found.

The *Bed* should resemble a fracture bed in all respects, particularly in smoothness and absence of sagging.

The Amount of Weight will vary in every case, and may be anything

between 3 and 12 lb It must be the smallest that will keep the limb at rest, but it must be sufficient for this, or it will simply act as a stimulus to the contracting muscles, and be actively harmful. It often takes some days for the spasm of the muscles to be exhausted.

The Direction of the Pull of the Stirrup. — The pull upon the limb in these cases should be in the direction of the deformity.

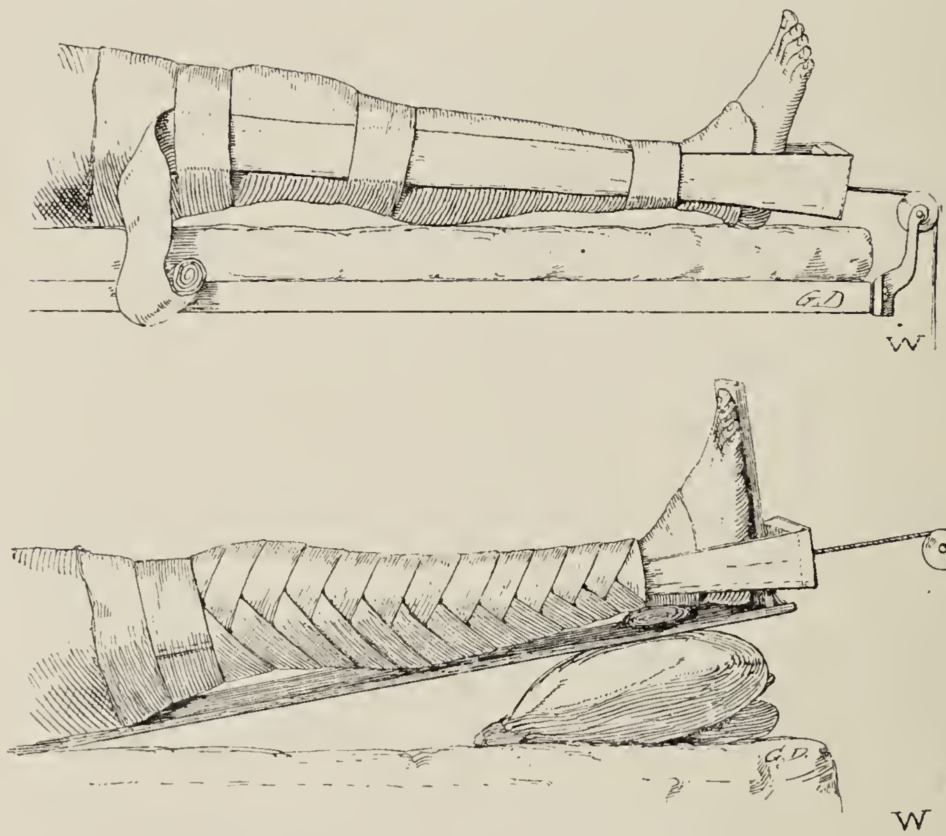


Fig. 176.—Stirrup and Weight in Position.

This is essentially a children's disease, and for this reason it is often difficult at first to secure the continuous supine position with the head low. When children have once learnt that rest means ease, they will lie flat and still enough, crying only when they are moved, or when weight is lifted from the leg. But at first it is often necessary to fasten a child down, and this can easily be done, as shown in the figure (*Fig.* 177), by a sort of harness of webbing by means of which the shoulders and chest are attached to the bedstead, or to a thin piece of wood running across underneath the mattress.

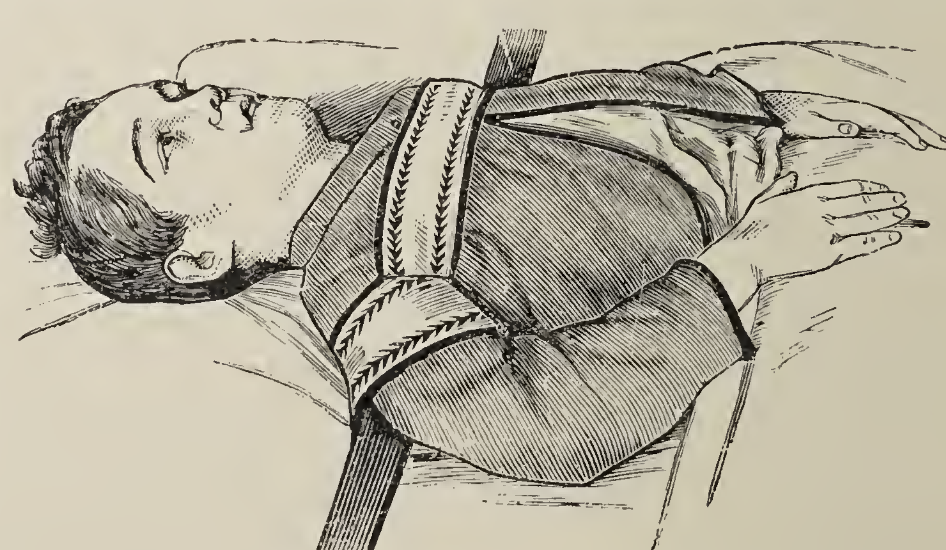


Fig. 177.—Method of Fastening down a Child in Bed.

The same result may be obtained, as will be described later, by putting the child in a Thomas's hip splint

No counter-irritant is considered advisable in these cases, perfect rest being the best treatment that can be followed.

II.—CHRONIC OR OLD-STANDING FORMS OF HIP DISEASE.

The treatment of these cases is to a large extent mechanical, since in nearly all of them some degree of deformity is present. In the cases we are now considering there is *no bony ankylosis*, and suppuration has either terminated or been absent throughout.

In these cases the general plan of treatment is to keep the *patient lying down*, and to try, by means of the stirrup and weight, to pull the limb gradually *straight*, the weight employed being generally greater than in acute cases The foot of the bed should also be more raised.

Unless the case be a very simple one, it will be found that the limb apparently lies straight enough directly the weight is put on, but if the hand be now placed below the lumbar spines, it will be seen that they form an arch to an extent corresponding to the deformity; in other words, *lordosis* of the back has been produced. The appearance of improvement is therefore quite deceptive, and the weight is doing little or no good. It must always be kept in mind that for the apparatus to be of any avail in reducing deformity, no lordosis must be allowed, that is, the *whole back must be in contact with the bed.* The only way to secure this is to make the *pull* of the stirrup almost in *the direction of the flexed and abducted femur* This may most readily be done by attaching the pulley-block to a standard placed at the end of the bed, so that it may be raised or lowered (*Fig* 178). The standard also may be shifted laterally.

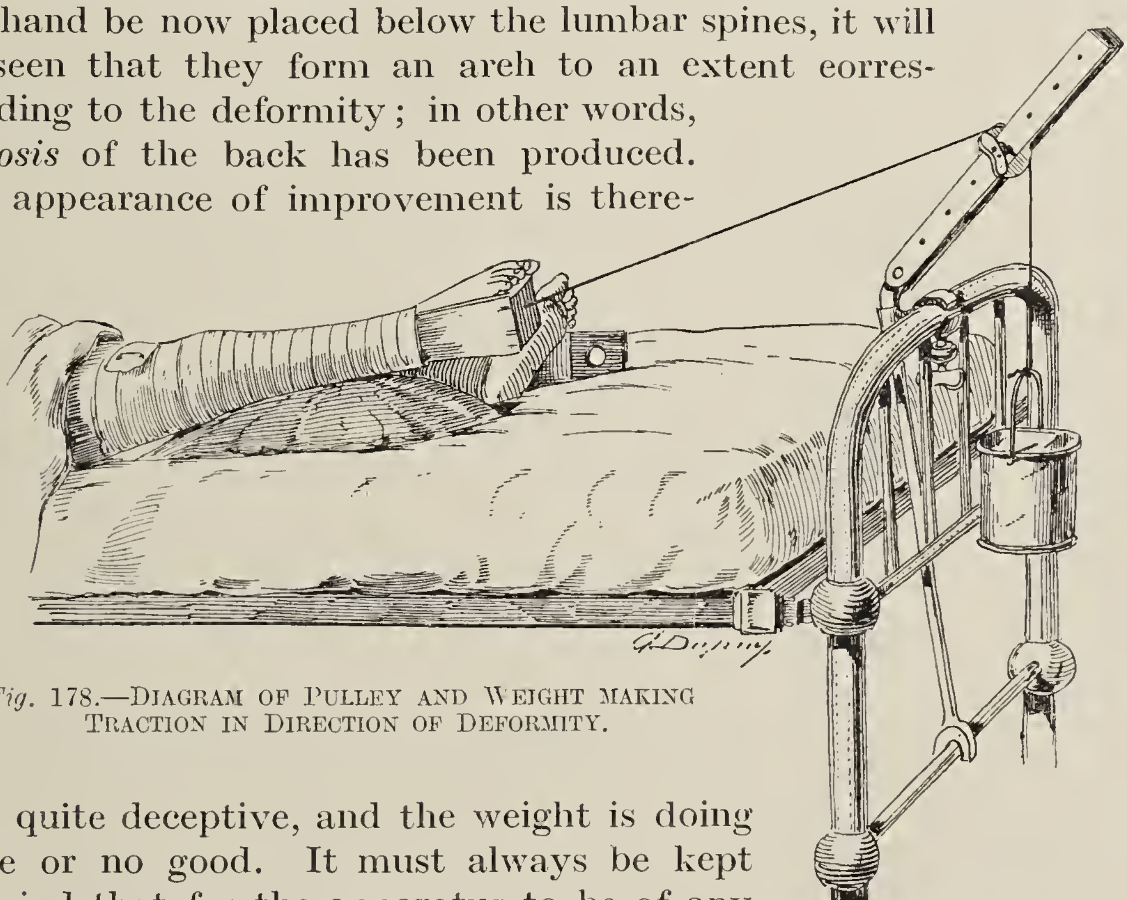


Fig. 178.—Diagram of Pulley and Weight making Traction in Direction of Deformity.

It is best to make no attempt at reduction of the deformity during the first week of treatment, but simply to get the parts at rest, and to abolish muscular spasm, by making traction in the direction which the femur assumes when the spine is flat on the bed. Then inch by inch, and very gradually, the limb may be *adducted and extended.* When the extension has done its work, if the parts are quiet and free

from pain, Thomas's treatment may be begun, but only if the limb is in a good position In more advanced cases the limb is more acutely flexed and *adducted*, under which circumstance the adduction must be overcome, as was the abduction of the earlier stage.

The Thomas Splint.—The mechanical principles on which many cases of hip disease may be successfully treated with little or no confinement to bed, are fully explained and advocated by H O. Thomas, in his book on this subject,* from which a quotation is made below, in order that the student may read in the inventor's own words the description and use of the splint. The account has been slightly condensed, and it has been thought as well to retain it in this edition for the benefit of those who do not live near to an instrument maker and can only employ a blacksmith to fashion the splint.

The *Objects of Thomas's Splints* are, first, to secure rest and to avoid friction, by means of posterior fixation of the hip-joint, together with the trunk, thigh, and leg ; and secondly, to allow the weight of the limb gradually to remedy the deformity in the place of a more active form of extension.

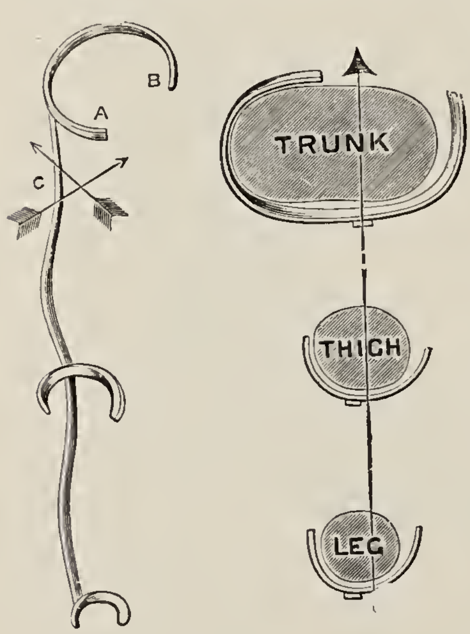


Fig. 179. *Fig.* 180.

Fig. 179.—SINGLE THOMAS'S SPLINT.
Fig. 180.—SECTION OF TRUNK AND LIMBS AT LEVEL OF THE HALF-CIRCLES OF THE SPLINT.

"We will suppose the patient, æt. 10, with right hip-joint disease. The surgeon requests him to stand on the left limb, and proceeds to measure him for the instrument. A block, or several if necessary, is placed under the sole of his right foot, until the sound limb is raised sufficiently to allow the spine to resume its natural form.

"Now he takes a long, flat piece of malleable iron, one inch by a quarter for an adult, and three-quarters of an inch by three-sixteenths for children, long enough to extend from the lower angle of the shoulder-blade in a perpendicular line downwards over the lumbar region, across the pelvis slightly external, but close to, the posterior superior spinous process of the ilium, and to the prominence of the buttock, along the course of the sciatic nerve, to a point slightly external to the centre of the extremity of the calf of the leg. The iron must be modelled to this track to avoid excoriations.

"The lumbar portion of the upright must be invariably almost a plane surface, and rotated on its axis in the direction of the arrows (*Figs.* 179, 180) more or less in proportion to the plumpness of the patient. The iron forms this upright portion. It is very necessary that it should come below the knee, to enable the surgeon to fix this joint.

* *Diseases of Hip, Knee, and Ankle Joints*, Liverpool, 1876.

" Then measure round the chest, a little below the axilla, deducting, in the case of an adult, four inches from the chest circumference. This latter will be the measure for the upper cross-piece, which is made from a piece of hoop iron, one and a half inches by one-eighth of an inch. The hoop is firmly jointed to the top of the upright with a rivet at one-third of its length from the end next to the diseased side (*Fig.* 179). It is important to give the upper crescent this oval shape, to assist in arresting the machine from rotating from its position behind the body, and thus producing inversion of the limb. Another strip of hoop metal, three-quarters of an inch by one-eighth of an inch, and in length two-thirds of the circumference of the thigh, is fastened to the upright at a position from one to two inches below the fold of the buttock ; and then another piece of metal of like strength, equal to half the circumference of the leg at the calf, is firmly riveted to the lower extremity of the upright.

" The short portion of the top half-circle is next to the diseased side, with a space intervening, while the long portion must be closely fitted to the sound side. If the machine should tend to rotate from the diseased side, then daily contract the long wing of the crescents, and expand the short ones.

" In applying the instruments with two uprights (*Fig.* 181), care should be taken to measure the distance between the tip of right and left posterior spinous processes, and then to set the uprights parallel and apart one inch more than such measurement, or it cannot be tolerated by the patient. The two uprights should be connected by a cross-bar when practicable.

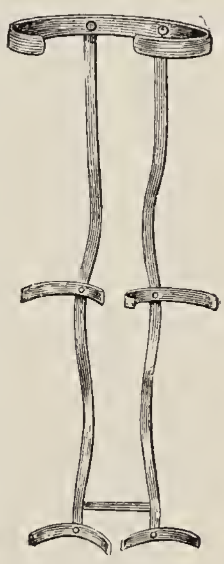


Fig. 181.
DOUBLE THOMAS'S SPLINT.

" The instrument is now ready to be padded and covered. The former is conveniently done with boiler felt, the latter with basil leather.

" It will often occur that some slight alteration will be demanded at some period during the progress of the case, and if it is one attended with much deformity, the surgeon will, for a few weeks, occasionally have to alter the curves of the appliance. This modification he should be prepared to perform himself, with wrenches.

" The patient being placed in the machine, the upper circle round the chest is closed with a strap and buckle, and the limb is bound with flannel from the calf upwards beyond the small crescent.

" It is very desirable that the patient should be confined to bed for a period at the commencement of the treatment. This preliminary reclination I have never noticed to injure the general health, but invariably improves the patient's condition, and shortens the acute stage.

" The surgeon, being satisfied that suppuration has been avoided during the first stage of the mechanical treatment, permits the patient to proceed on to the second stage. He is then allowed to go about

with the assistance of crutches, the frame is continued, and an iron patten at least four inches in depth is placed under the shoe of the sound limb (*Figs.* 182, 183).

"Now we come to the third stage. The patient takes off the frame-work in bed and replaces it during the day, still using the crutch and patten for a certain period.

"We now arrive at the fourth stage. The patient totally discards the frame, and uses the crutch and patten only. These he sets aside after the surgeon is well satisfied with regard to the permanence of the cure. If the case does not progress to the satisfaction of the surgeon, some of these stages must necessarily be prolonged.

Fig. 182.—Thomas's Splint Applied—Front View.

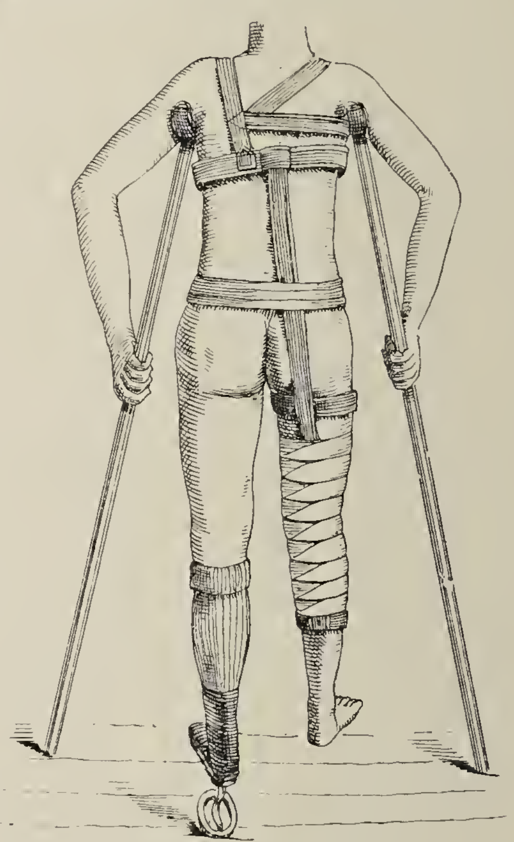


Fig. 183.—Thomas's Splint applied—Back View.

(Reduced from Thomas's book.)

"The weight of the lower extremity is equal to reducing any angular deformity of the hip- or knee-joint, not resulting from true ankylosis, and is capable also in some degree of diminishing any shortening, should absorption of the head of the bone occur, provided a suitable mechanical arrangement be applied and continued during a sufficient period."

The advantages gained by not having to confine the patient to bed are certainly very great, if the splint fit properly and be well looked after, but we are strongly in favour of starting treatment with a weight extension, the splint being applied subsequently when the deformity has disappeared.

The flexibility of the lumbar spine is always very great, and is especially marked in children; the patten should therefore be in them not only relatively but absolutely as high as, or higher than, is necessary for adult patients.

CHAPTER XXXIII

OF SPINAL DISEASE

SPINAL disease, whether rachitic or tuberculous, may require a long period of immobilization for its permanent cure; such cases, since they only occasionally need active surgical treatment, are sometimes neglected. It may be taken as a general rule that tuberculous disease of the spine can be cured, in the majority of cases, by rest and other appropriate treatment.

It was formerly the custom to treat many of these cases by the 'spinal jacket,' a treatment which should be reserved for special cases in the final stages, when a satisfactory state has been brought about by prolonged rest

In the early stages, when the disease is active, as shown by the pain and rigidity—even though no deformity be present—the child

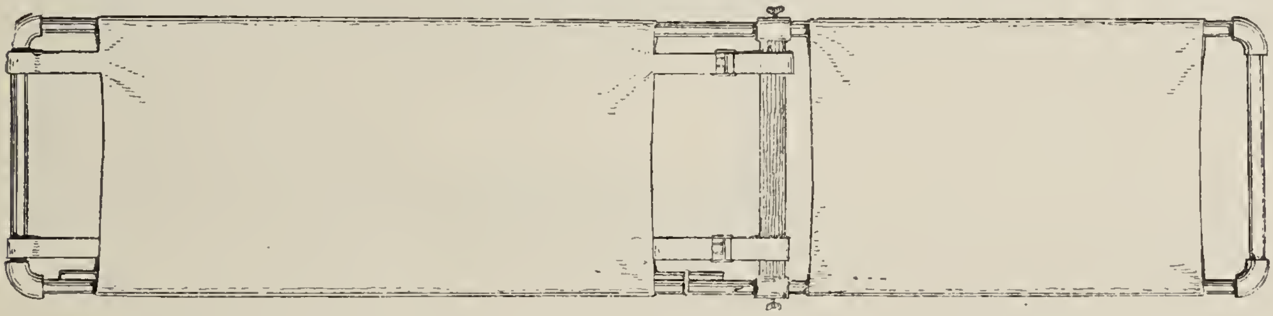


Fig. 184.—Bradford and Lovett's Frame for Cases of Spinal Disease.

must be fixed firmly to some strong support, so that absolute rest is obtained.

In the case of very young children this can be done without anything more complicated or expensive than a wooden box-lid, or a flat piece of basket-work carefully padded, or a frame splint (*Fig.* 184), upon which the child is fixed with straps. If there is any angular deformity, special care must be taken to protect the projecting parts from friction and injury.

In the case of older children, indeed in the vast majority of cases, Phelps's box (*Fig.* 185) should be employed, a form of treatment which gives very good results

Phelps's Box is a hollow trough of wood lined with padded cushions. At the lower end there are two smaller troughs which receive the legs, and into which they are firmly bandaged. The trunk is fixed to the main part of the box by broad bands of webbing. The lower extremities being fixed in a position of abduction, the action of the bladder and rectum can be attended to readily, with a minimum of soiling and trouble.

In fitting a Phelps's box the following points should be attended to :—

1. Projeeting bony points must be protected by speeial pads.

2. Allowanee must be made for growth : at least six to eight inches when the splint is first fitted

3. Speeial eovers, whieh ean be washed, should be placed over the lining cushions.

Onee a week, or oftener if necessary, the ehild is to be taken out, plaeed flat on a bed, and washed. Ordinary elothes can be worn, but some ingenuity will be needed in fitting them so that they ean be put on and taken off with the least disturbance.

The ehild must remain in the box for at least eighteen months for tuberculous disease : often longer if there has been any return of aetive symptoms : after which a spinal jacket may be fitted and worn until the subsequent course of the ease shows the disease to be quiescent.

During this treatment the child must be kept in the open air as mueh as possible ; or taken to the seaside, if it can be arranged, for a long period. Cod-liver oil and tonies should be administered. Children bear this confinement very well. At regular periods the child should be brought up for examination, and the surgeon direets his attention to the following details :—

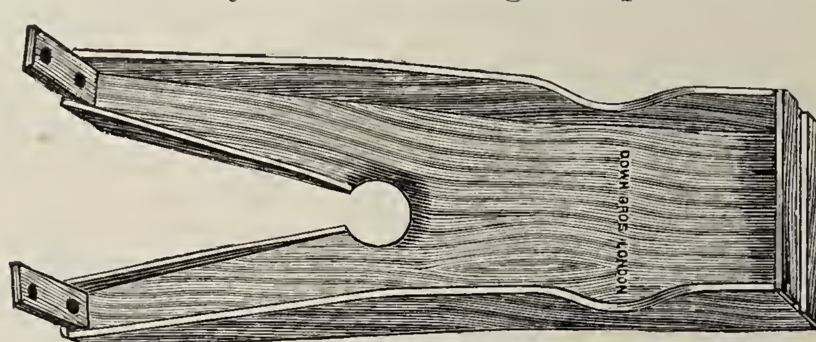


Fig. 185.—Phelps s Box Splint.

1. Has the patient complained of pain, a symptom suggesting that the disease is still active ?

2. Is there any swelling or fullness in those positions where abscesses are likely to point ? (*a*) Lumbar region ; (*b*) Internal to anterior superior iliac spine ; (*c*) In Searpa's triangle. These are the commonest situations in whieh abscesses are found, but when the disease is situated higher up in the spine, the abscess may appear in other positions, which are deseribed in the surgieal text-books.

In eervical earies, wateh must be kept for retropharyngeal abscess.

3. Has the ehild any trouble with the urine or fæces ? These are often the earliest symptoms of paraplegia, and from time to time examination must be made to see whether this complication has developed

4. Is the box causing any injurious pressure upon the projecting spine ?

Cases of *high cervical caries* are not suitable for 'box' treatment. The patient should be kept in bed, lying quite flat, with a small pillow under the hollow of the neek and sand-bags placed on either side. If the ehild is restless and refuses to lie still, an extension eollar with weight and pulley may be applied (*Fig.* 186), or a poroplastic splint moulded to the upper part of the thorax, head, and neck.

High caries is especially dangerous owing to the involvement of the transverse part of the crucial ligament and consequent risk of dislocation of the odontoid process.

The use of an extension apparatus is especially valuable when symptoms of paraplegia are appearing, and should always be given a thorough trial before operative measures are considered.

When all signs of actual mischief have disappeared, a jacket, jury-mast, or other form of support may be fitted, in order that the patient may get about.

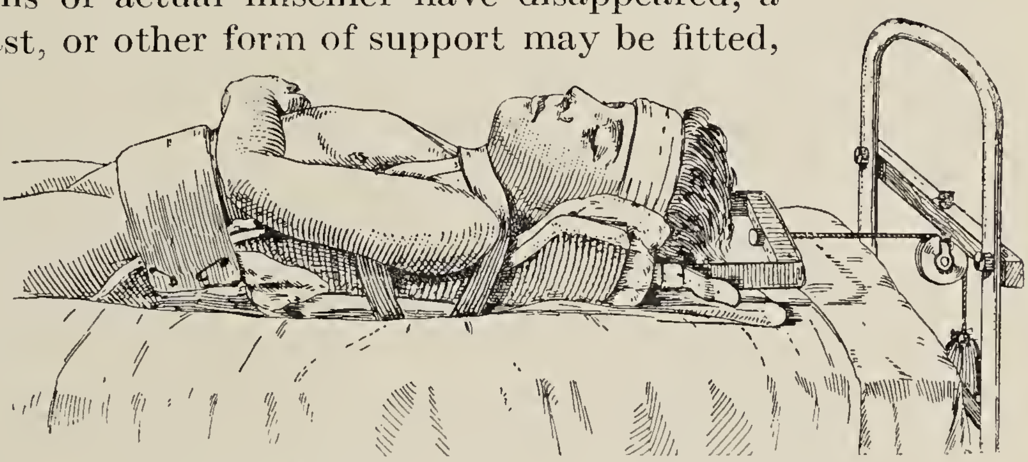


Fig. 186.—Method of Treating High Cervical Caries.

No fixed rule can be laid down as to the length of time that should elapse before this apparatus is discarded, but generally speaking it should be in a year to eighteen months.

The question of splinting the spine by means of a bone transplant, after the method of Albee, will be considered by the surgeon in charge of the case.

JACKETS.

These are made of plaster-of-Paris, leather, and poroplastic or resinous felt, all of which can be moulded to the body. Plaster is not so popular as it was, for, although cheap and easily applied, it is apt to crack and become soiled, and it is, in addition, unnecessarily heavy.

Plaster Jacket.—The end desired is to *immobilize the spine* about the seat of the disease, and to fix the whole spine *in the best position possible*, that is, with as little curvature and rotation of the vertebral sections as the extent and stage of the disease will allow.

To do this by means of any splint or case moulded to the body, it is obvious that it must be fitted : (1) While the trunk is as much extended as it may, or rather as it ought to, be ; (2) With the thorax in the position of inspiration ; (3) With all bony prominences protected ; (4) With a good hold on the pelvis to serve as the basis of support.

It must also be as light as is compatible with strength, and be loose enough over the abdomen to allow of moderate distention by food or flatus.

The Extension of the Trunk may be attained by Sayre's method of suspension, or, in the case of children, by simply holding them up with the hands in the armpits, or by the inclined plane ; this latter, however, cannot be used for the ordinary plaster case.

Of these three methods, the *suspension* from the tripod requires the most care. As shown in the figure (*Fig.* 187), the patient can be suspended with the feet just *off* or just *on* the ground—in England the general practice, with which we thoroughly agree, is not to swing the patient clear of the ground—by means of straps and padded slings, which pass round the head and beneath the axillæ, and are attached to a cross-bar, itself connected with a cord passing over a system of multiplying pulleys. By means of this cord, partial or complete suspension may be attained by the patient himself, or by an assistant, with a very moderate amount of force.

In severe cases, or if there be any loss of power in the legs, the patient may conveniently sit under the cross-bar, inside the tripod, and have the slings adjusted.

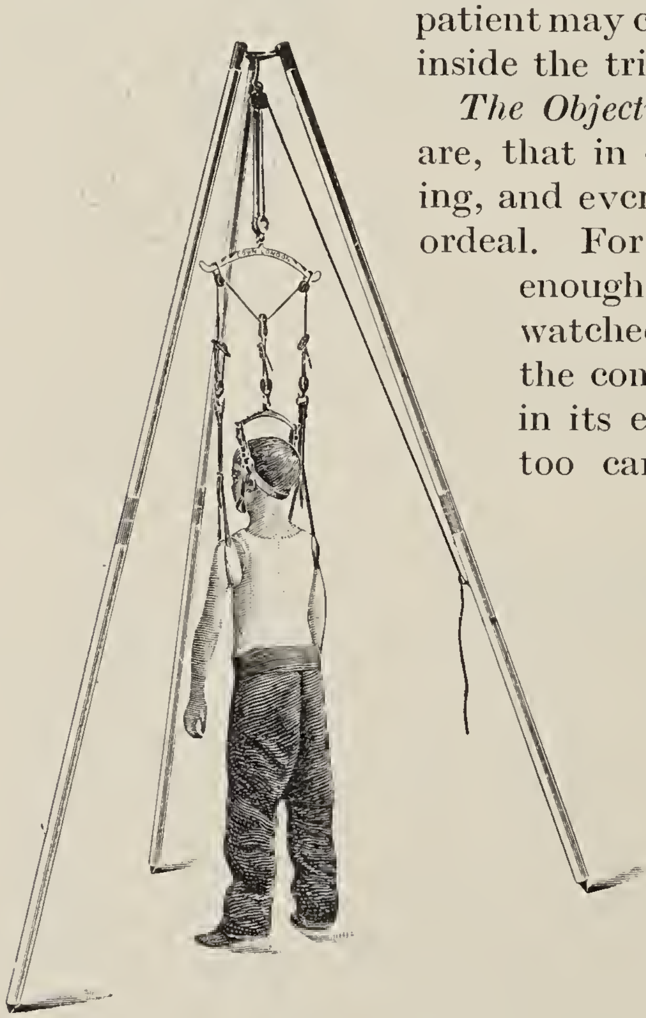


Fig. 187.—Suspension (partial) by Tripod and Pulleys.

The Objections to the Suspension Apparatus are, that in children it is alarming and fatiguing, and even for adults it is generally a trying ordeal. For most cases it is no doubt safe enough, but delicate patients must be watched lest faintness come on ; and if the consolidation of the vertebræ be only in its early stages, it is impossible to be too careful not to inflict damage by forcible extension. Unfortunately, it is difficult to estimate the force which is being employed, owing to the multiplying pulleys.

Speaking generally, however, it may be said that for adults, if the ordinary plaster case is to be applied, *gentle suspension* from the tripod, in the standing or sitting position, will be best ; but that for young children, suspension by an assistant with the hands in the armpits is much to be preferred.

The *Simple Inclined Plane*, with the arms thrown over the head and grasping a bar, is even a better and safer way of producing extension in the position of inspiration. This position cannot be maintained while a bandage is being rolled on the trunk, so that it will not do for an ordinary plaster case ; but for the poroplastic jacket, or for a modification of the plaster one to be presently described, it has much to recommend it.

The Inspiratory Position of the chest-walls is secured by the raising of the hands, if the inclined plane be used, and this is the case also with the tripod, if the patient be self-suspended ; if not, the hands

may be raised to grasp the legs of the support, but the management of this is often a difficulty. In holding up children by the hands in the axillæ, it is easy to maintain the desired position of the arms and chest-walls.

The Protection of Prominences is most important. Not only the angle at the curvature of the spine, if one be present, but any other projection which seems in the least likely to be rubbed, must be protected by pads placed on either side, or around, but not over it. The pads are best made of tow, covered with old table-linen, and are placed in position next to the skin. Careful moulding of the case to all irregularities, by pressing and squeezing it into shape before it sets, will also prevent chafing.

The Hold on the Pelvis is very important, and its neglect is the most common cause of failure of the treatment. If the case merely encloses the trunk as in a barrel, there is no relief afforded in the way of support for the weight of the head and upper extremities, nor is rotation of the spine at all prevented. The requisite grip is easily secured by taking care to bring the bandage, or the felt, at least $1\frac{1}{2}$ inches below the iliac crest, and to mould the case to the prominence of that bone.

We will pass now from the consideration of the general principles of the jacket treatment, to a description of the actual application of the common plaster jacket, of its modifications, and of the poroplastic jacket.

Application of the Plaster Jacket.—A time should be chosen not less than two hours after a meal, if possible upon a dry day, and there should be a fire in the room in which the operation is to be performed. A firm horse-hair mattress should be laid on the floor near the fire, ready to place the patient upon as soon as the jacket is adapted.

The patient is then stripped, and the singlet or jersey which is to go under the jacket, and which should be of a kind specially made for the purpose, is slipped on, and the tags for the shoulders tied or fastened with safety pins (on no account must an ordinary pin be used anywhere in these cases). The pads must then be adjusted to protect the angular curve. If the abdomen be unusually retracted, it is wise to place a temporary pad to bring up the circumference of the jacket there to its normal size. The permanent pads at the back or elsewhere should be fastened to the jersey with a stitch or two, after they have been carefully adjusted. The bottom of this garment is then fastened, back and front together, between the thighs, with a safety pin.

If the patient is a girl about the age of puberty, care must be taken to leave room for the developing breasts. This is usually done with pads in the same way that allowance is made for any temporary enlargement of the stomach by a meal.

All is ready now for suspension. In the case of a child, as we have said, this is best performed by an assistant placing his hands in the

axillæ, so as to grasp the arms at their highest point. The child can thus easily be held with the shoulders well thrown back and with the toes just touching the ground. But if *suspension by straps and pulleys* is to be employed, the patient must have the head and shoulder-slings of the tripod adjusted so as to give an equal pull upon every part, as seen in *Fig.* 187. The straps of all the slings, and of the chin and occiput supports, can be altered to suit different patients, and too much care cannot be taken to get the support exactly right before applying the bandage. As a general rule, the patient stands for the suspension ; but if there be great weakness, or any paralysis, or simply if it be found more comfortable, a seat without a back (a rotary music stool does best) may be placed beneath the tripod.

When the slings have once been adjusted, the actual raising should not be made until everything is ready for the application of the bandage, and in our opinion it is never advisable to swing the patient quite clear of the ground or stool.

The general manipulation of rolling on a plaster-of-Paris bandage has already been described (Chapter XI), and this particular form does not differ in any essential point.

Six or eight freshly rubbed muslin bandages will be required, and both they and a small quantity of loose plaster should be put into an oven for about an hour before they are wanted. In moistening the bandages, a large basin of warm water should be used ; as soon as one is ready, it is taken out and another is put in the water, while the surgeon rapidly rolls the first on to the trunk of the patient, allowing the bandage to take pretty much its own course, but endeavouring to work generally in figures-of-8, the upper loop encircling the chest and the lower one grasping the pelvis. The bandage must on no account be drawn upon, but merely rolled on. When the first is finished the second is taken out of the water and a third one put in, and so on. As a rule, for a child of eight years of age, four bandages will be enough to make a jacket three layers thick everywhere, and four layers in the parts that require most strength. For an adult, six will generally be necessary.

While the bandages are being rolled on, an assistant should rub in additional loose plaster with the hand, moistening it as is required ; and when all the bandages are put on, the whole jacket must be worked over with moistened plaster, well rubbed in, until the surface has a uniform smooth feeling. The prominences of the pelvic crest and the spine must now be moulded before the plaster sets.

All this must be done very quickly, for the position is a fatiguing one. In most cases it is wise to have one assistant whose whole care is to watch the patient, and to look after the suspension. If, in the process of applying the jacket, any symptoms of embarrassment, either of the breathing or the circulation, appear, the patient must be promptly let down.

When the application is finished, some patients, if there be no

great discomfort, may be left partly suspended for about ten minutes while the jacket begins to set, but as a rule it is advisable to remove them from the apparatus as soon as possible, and lay them flat on the mattress placed ready on the floor near a fire. The removal must be made with great care, so as to avoid any cracking of the case. Hot-water bottles, or hot bricks, laid near the case, will hasten its drying, especially in damp weather.

As a rule the patient had better remain still for three or four hours while the case is setting. It will then probably require a little trimming and cutting away in the armpits, etc., which can conveniently be done with a sharp knife.

The safety pin in the perineum, and the stomach pad, when present, can be removed as soon as the patient is laid down.

Fig. 188 is drawn from a case of angular curvature of ordinary severity, in which a plaster case had been applied.

In the poor, particularly when a child is allowed to go home with a jacket on, some means must be taken to prevent vermin getting inside the jacket. Soaking the jersey in boric acid, or sprinkling the skin with it, is generally sufficient.

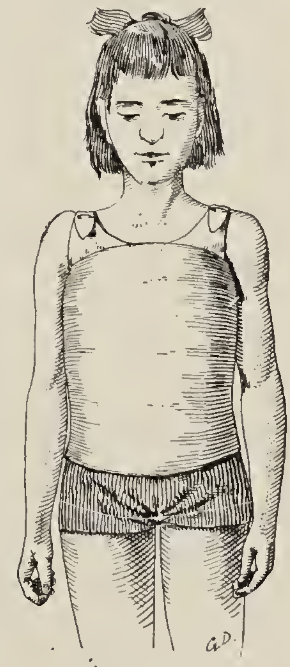


Fig. 188.
Plaster-of-Paris Jacket applied.

One great drawback to this treatment is the impossibility of getting at the skin to wash it, or of cleansing the jersey. If only one jersey be used, it cannot be changed without making a new jacket.

There are two ways in which this difficulty may be partially overcome. The first, recommended by Keetley, consists in laying two clean handkerchiefs or napkins, back and front, between the jersey and the skin (and of course inside the pads) before the jacket is applied. When these have to be changed, it is easily done by pinning a clean napkin to the lower edge of the soiled one, which should project a little below the plaster jacket; then, by pulling the latter out at its upper end, the new follows the old one and lies in its place.

The other way is on the same principle, and is Oxley's device. Two jerseys, instead of one, are worn throughout the treatment (the pads being fastened to the outer one only). The outer one adheres to the plaster, and forms part of the case, but the inner one can be removed by pulling it off, over the head and shoulders, after having tacked a clean one to its lower edge all round.

Poroplastic Jackets.—The moulding of *resinous felt* into a spinal jacket does not differ in its main principles from the moulding of that material for other splints, but the large amount of felt employed, together with the great rapidity with which it sets, makes a certain amount of practice necessary in order to be able to fit a case of spinal curvature properly.

Advantages.—A well-fitted poroplastic jacket is often an admirable method of treatment. It is not much more than half the weight of a plaster one, it is porous, so that the action of the skin is but little interfered with, and it can be removed altogether, or widely loosened, at frequent intervals, for the purposes of cleanliness, although it will not long stand being taken off every night, as is sometimes advised.

These jackets are sold roughly blocked out (*Fig.* 189) in a sufficient number of sizes, and of three qualities, of which the two most expensive are about equally good, though the dearer one is rather the lighter of the two. The third and coarsest quality is not recommended.

The jackets are fitted with the necessary straps, buckles, and eyelet holes, and an additional improvement is to leave unstiffened the felt corresponding to the front iliac spines, and (in women) to the breasts, as shown in the figure. Other parts may also be left unstiffened as required, as over tender prominent ribs, or spinous processes.

A jacket of about the right size having been chosen, it must be *accurately fitted* to the body of the patient while the position of extension is maintained.

One way of doing this is to take a plaster cast of the trunk, and block the jacket upon that instead of upon the body. This is a plan very generally followed by instrument makers, and has this advantage, that any number of jackets can be moulded in the future without further trouble to the patient. But the first cast is difficult to make, except by a professional modeller, and, generally speaking, the position of extension is not well maintained. A cast, however, would be absolutely necessary if leather were used instead of felt.

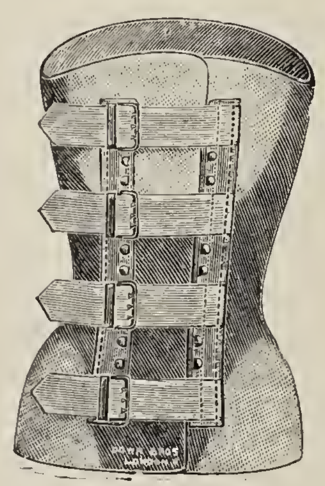


Fig. 189.—Poroplastic Felt Jacket.

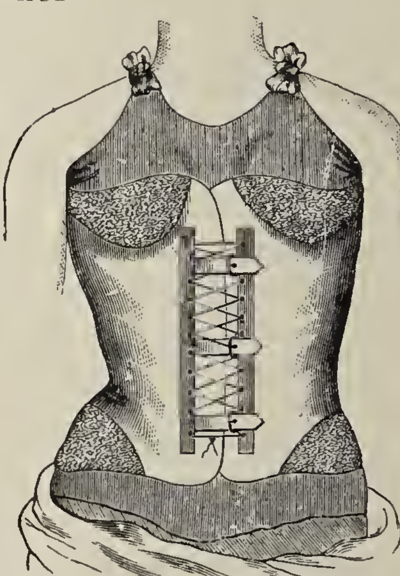


Fig. 190.—Poroplastic Jacket applied.

But the general practice is either to suspend the patient from the *tripod*, or to procure the extension and the inspiratory position by means of an *inclined plane*. As we have said before, we consider the latter is, in ordinary cases, to be preferred.

In either case the fitting of the jersey and pads is just the same as if a plaster jacket were about to be made, and if the tripod be used, the head and shoulders are adjusted exactly as has been described before. If the plan of the inclined plane be chosen, the patient lies down on it, and, raising the arms above the head, catches hold of some bar or support. The best inclined plane is the simplest, namely, a board about two feet wide, and with an inclination of about

two feet in six. There must be no foot-piece, nor any pillow for the head.

The same method of *softening the jacket* can be employed in either case. This can be done very well in a good-sized oven at the ordinary cooking heat, in which the jacket should be suspended from some support, such as a surgical cradle ; it must hang free, and must not touch the sides anywhere, or it will burn ; it must also be well moistened, and a pan of water should be placed on the floor of the oven.

A more convenient plan is to use a specially contrived *steam chamber*, sold or let out by instrument makers, and which consists of an iron cylinder with a double bottom, into which an oil stove-lamp, a spirit-lamp, or a gas-jet is put. A pan of water stands within the cylinder, which has a tight-fitting lid.

The lamp quickly generates the steam, and there should be heat enough to soften the jacket thoroughly in three or four minutes. It is then ready for application, and must be *at once* and *as quickly as possible* put on. The patient being suspended from the tripod, an assistant (who is advised to have gloves on) quickly draws, first the waist-strap and buckle together, then the pelvic ones, and lastly those about the breast, the responsible surgeon the while moulding and kneading the felt to the prominences of spine and other parts.

This is a good plan to follow, but a better is to have, ready cut, six or eight lengths of broad, stout bandage stuff ; then, whether the patient be suspended or be lying on the inclined plane, the jacket can be quickly slipped on and the sides brought round into position, care being taken that the softened parts of the felt correspond to the hips and breasts, and that the buckles come opposite the straps. The lengths of bandage are then quickly passed round and knotted in front by the assistant, while the surgeon brings the sides accurately forward, and moulds them as he does so. The waist bandage is tied first, then those for the hips, the breast ones next, and then intermediate ones as may be required. In this way all fumbling with hot buckles and straps is avoided, the jacket is easily put on before it can set, and a closer, more accurate fit is attained.

The jacket sets too firmly in a minute or two for any further moulding to be done, but it is not really strong for about half an hour, so the patient must lie still for that time, if on the plane, or may remain semi-suspended if this can be borne, or, as in the case of the plaster, may be carefully released from the tripod and laid flat on a mattress, but in this case *not* close to a fire.

When the felt has set, the bandages may be cast off, and the straps and buckles closed. These will very likely require some adjustment, and for this reason it is often wiser to mould the jacket *before* the straps and buckles are sewn on. The jacket itself will almost certainly have to be cut away somewhere, or slightly altered, and this may be done in one of two ways, as may seem best : namely, with a hot iron, which will re-soften parts that do not quite fit, or by dissolving the

resin out of the felt with spirits of wine sufficiently to make it much more pliable. This is often a very good plan for such parts as the armpits.

If the jacket be a failure, or if, as ought to happen in the progress of a case, it seems as if a further improvement were possible, the case must be slipped off and re-softened in the steam chamber, unless it be badly cracked, or be worn out.

In *Fig.* 190 is shown a felt jacket moulded to an adult case of bad lateral curvature. In this case a similar jacket had been worn for several years.

Cervical Caries—Jury-masts.—When the seat of the spinal disease is in the cervical region, it is obvious that no jacket can, of itself, fix the vertebræ. In acute cases it is generally necessary to make the patient lie absolutely flat, with the head fixed with *pillows and sand-bags.*

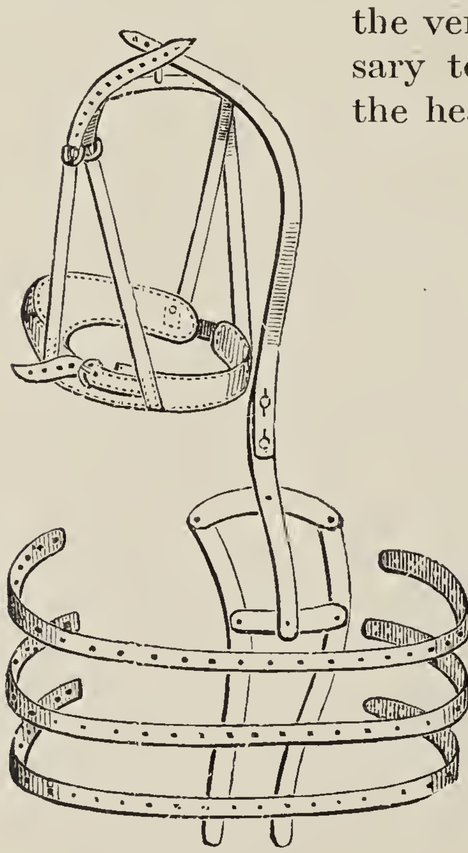


Fig. 191.
JURY-MAST FRAME.

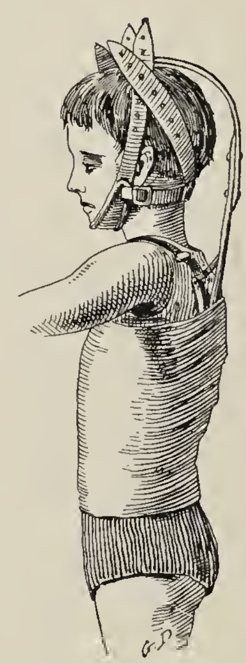


Fig. 192.
JURY-MAST APPLIED.

But there are many stages in the disease in which it is both safe and advisable to allow the patient to get about, provided that in some way or another the weight of the head and neck can be taken off the diseased vertebræ. This may be done by the simple plan known as the 'jury-mast' system.

Its main features can be seen in the accompanying figure (*Fig.* 192). It consists of a light plaster jacket, from which springs the mast itself, which is a light bar, with a joint for the adjustment of its length, arching overhead, and having a cross-yard about five inches long, from which hang straps to support the head from the chin and occiput.

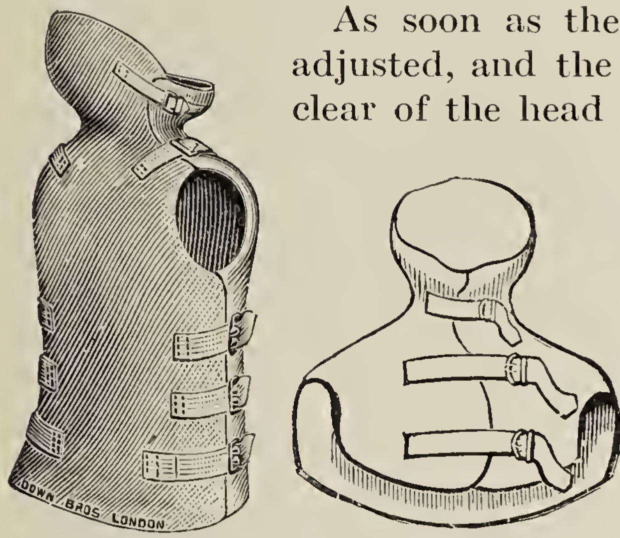
The mast is forked below, so as not to press upon the vertebral spines, and has attached to it thin strips of tinned iron, with pierced rough holes ; these go round the body and are worked into the plaster jacket (*Fig.* 191).

In fitting the mast, the steel bar should first be bent with wrenches to the right shape, and then tempered. The exact height may be afterwards adjusted.

The jacket may be put on with or without suspension, as may seem best, but if the tripod be used, the greatest possible care must be taken not to put too much strain on the vertebræ of the neck. The

plaster jacket must be as light as will fix the mast, which, with the cross strips, is imbedded in its substance, having layers of plaster both above and beneath the iron.

As soon as the jacket is set, the straps may be adjusted, and the length so fixed that the bar is just clear of the head when the latter is supported to the extent which gives greatest relief. This height will have to be altered from time to time.



Figs. 193, 194.—Poroplastic Jackets for Cervical Curvature.

Leather Jackets are very expensive and rarely ordered. They are, however, very serviceable in cervical caries instead of a jury-mast, and they have the great advantage of fixing the head more firmly than any other form of apparatus.

A poroplastic jacket (*Figs.* 193, 194) is an excellent splint for high cervical caries.

CHAPTER XXXIV

OF GENU VALGUM AND VARUM, TALIPES, ETC.

GENU VALGUM OR KNOCK-KNEE.

PUTTING aside those cases in which some operation about the femur or the knee-joint seems to be advisable, much may be done by a patient use of the simplest forms of splints : in very young children especially, quite as much as, and probably more than, can be effected by the most expensive forms of instruments.

Two Outside Splints of a simple pattern (*Fig.* 195) will be found quite efficient for most cases. These may be fastened on by webbing straps or by broad pieces of strapping. In either case, one strap, or strip of plaster, must always go over the knee, as shown in the figure. Long, thick stockings had best be worn beneath the splints, or a flannel bandage may be applied instead ; a calico bandage may be put on over all if the webbing or strapping fails to fix the splint firmly enough.

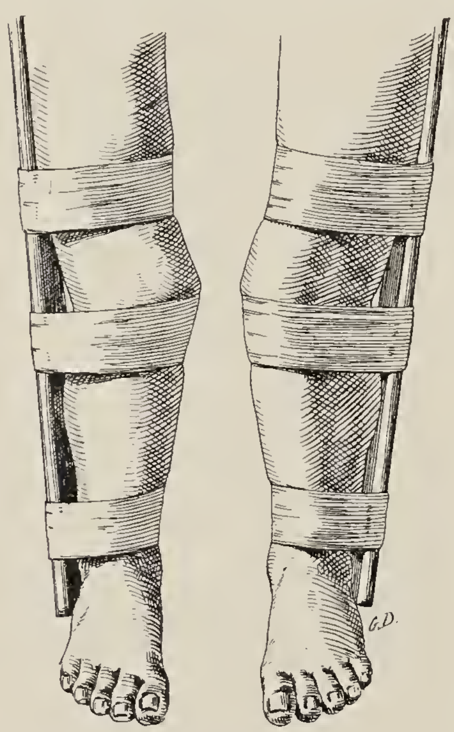


Fig. 195.
SIMPLE SPLINTS FOR GENU VALGUM.

In bad cases, or in those which are quickly getting worse, it is best to wear the splints continuously, only taking them off night and morning for re-adjustment. But in slight cases, or in those on the road to recovery, free movement in bed may be allowed, and the splints put on the first thing every morning.

Another plan is to put up the legs in light *Plaster-of-Paris* cases, stiffened if necessary by a wooden splint on the outside. While the plaster bandages are being put on, the knock-knee must be forcibly straightened as much as it will bear. The new position of the limb will be retained by the splint, and when this has been worn a short time (say three weeks), it may be taken off, and a further forcible straightening effected and retained in the same manner.

Valgus of the knee is often associated with that of the foot. Whether this is cause or effect is a much disputed point ; but in any case both conditions must be attended to.

BANDY (OR BOWED) LEGS, CURVATURE OF THE TIBIA, ETC.

Simple bandy-leg, or general outward curvature of the tibia, inasmuch as it is nearly the reverse of knock-knee, may be well

treated on just the same lines, the splints being put on the inside instead of the outside of the legs. This condition yields to treatment more readily than valgus of the knee.

The curved tibiæ which occur as a consequence of rickets are now far more frequently treated by *Section of the Bones* with a saw or a chisel than formerly. If properly performed, the operation is practically free from danger, and is followed by excellent results, but it must not be undertaken until all rachitic symptoms have disappeared.

Splinting.—But the number of rickety legs which can be improved or cured by proper splinting will always be very large as compared with those in which osteotomy is at all called for, and common light wooden splints are infinitely preferable to 'irons' of any kind.

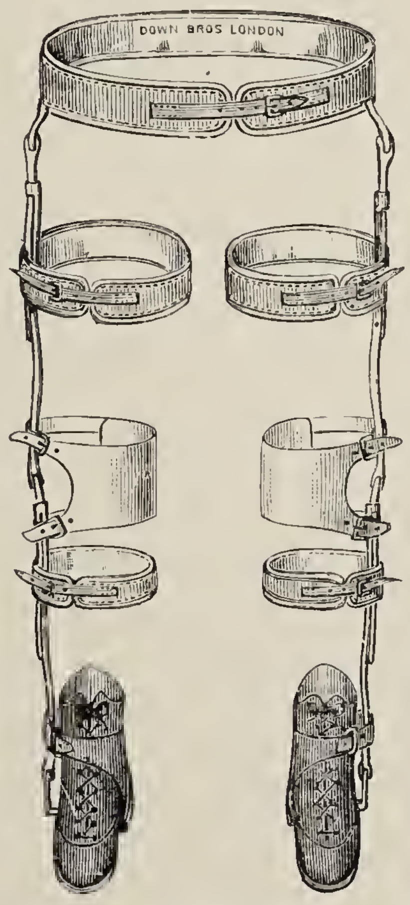


Fig. 196.—Splints for Genu Valgum.

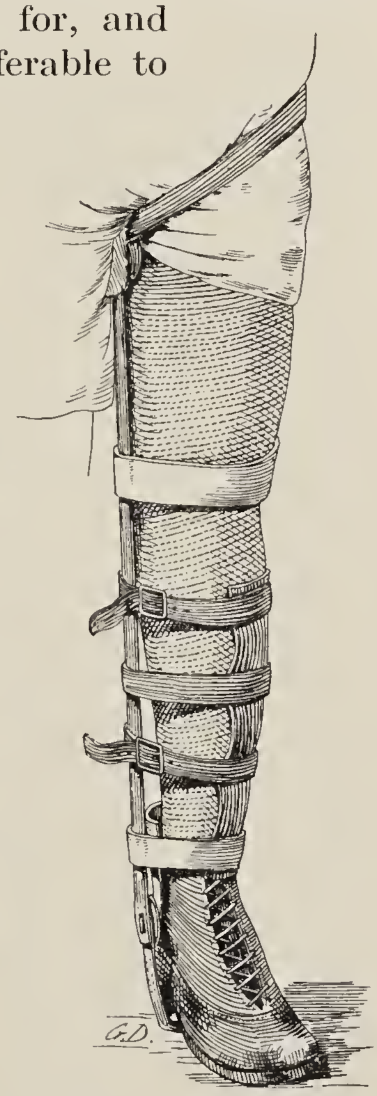


Fig. 197.—Splint for Bandy-leg, attached.

(Diagrams of apparatus for use in late cases when patient begins to walk.)

The length and method of attachment of these splints will depend a good deal upon the stage of the disease, and upon the age of the patient. In the *Acute Stage of Rickets*, and especially if the children are quite young and are only just beginning to 'feel their feet,' it is best to keep them from bearing any of their weight, often increased by a tumid belly and a heavy head, upon the yielding leg and thigh bones. In this case the splints had better be worn day and night, always being adjusted morning and evening. They must be well padded, and should extend three or four inches below the foot, being attached by bandages or webbing straps, and fixed to the inner or outer side of the limb according to the needs of the case. If this length does not succeed in keeping the child off its feet, they may be made of different lengths, and if this fails, the legs must be tied together, or some such plan as was described in the chapter on hip disease must be adopted. (*See Fig.* 177.)

As a rule, webbing straps and buckles are here better than strapping

or bandaging. A broad strap should always go round the place of greatest curvature. The limbs should be well rubbed morning and evening for ten minutes, so as to improve the nutrition of the muscles. As the improvement continues, and the bones consolidate, the splints may be left off at night, and finally abandoned altogether, or the apparatus shown in *Fig.* 196 or *Fig.* 197 may be employed.

CLUB-FOOT.

The different kinds of club-foot are very numerous, and the cases of each variety of the deformity differ very much among themselves in the extent to which they are amenable to treatment, and as to whether one plan of treatment or another is the more suitable.

Club-foot consists in a twisting or deformity of the foot, with the result that it is displaced inwards (varus), or outwards (valgus). These primary displacements are really associated with some undue shortening or lengthening of the tendo Achillis. In the former there is inability to dorsiflex at the ankle, and the child will later walk on the tips of the toes, the heel failing to reach the ground ; in the latter, the foot is dorsiflexed to such an extent that the dorsum may be in contact with the anterior tibial region.

These forms of club-foot arise from two main causes :—

1. *Acquired.*—Infantile paralysis, or anterior poliomyelitis, is responsible for most cases. A few are due to more extensive spinal lesions. Certain groups of muscles become paralysed, and they are then unable to oppose the action of those which have escaped, with the result that the foot is pulled into a bad position by the active muscles. Other causes of acquired talipes are peripheral neuritis, faulty splinting after fractures, or contractions caused by burns.

2. *Congenital.*—A form dependent upon some malposition of the fœtus in utero. There is no paralysis, but in severe cases there has been so much interference with the development of the tendons and ligaments, and so much contraction of the foot tissues, that very lengthy treatment and a great deal of patience are required.

Paralytic Varieties of Club-foot.—These should be recognized at the earliest possible moment—that is, as soon as the effect of the damage to the anterior horn cells is shown by the loss of power in the limb and the acquirement of some deformity. The commonest form is a talipes equinus owing to damage to the anterior tibial muscles, but the other groups—peroneal and posterior tibial—may be attacked. On examining the limb it will be noticed that the muscles do not contract voluntarily, and that they give the reaction of degeneration. Occasionally one muscle of the group, such as the extensor longus hallucis, may escape. Experience has shown that if the nutrition of the muscles is maintained by massage and *electrical treatment,* and if nerve tonics such as strychnia are administered, there is a fair extent of recovery in a large number of cases. Such treatment should be undertaken at once, and during this time the limb must be kept in

a good position by means of splints. When the paralysis persists, such measures as tendon grafting, tendon lengthening, or arthrodesis may be advisable ; they will not, however, be discussed here. Failing these, a boot should be ordered which will tend to correct the deformity (*Figs.* 198, 199). In talipes equinus a spring should be placed under the anterior part of the foot to tilt it up, while the flail-like movement of the ankle-joint may be controlled by means of special hinged irons.

Fig. 198.
LEG STEM, with stop ankle-joint, for slight cases.

Fig. 199.
LEG STEM, with S-springs to raise front part of foot.

Other forms of acquired talipes should be treated by tenotomy.

Congenital Talipes—T. Calcaneus.—The foot is strongly dorsiflexed at the ankle, and is longer and narrower than usual. Operative treatment is rarely required ; it is usually sufficient to massage and manipulate the foot so as to stretch the shortened tendons. If this is persisted in from the earliest possible moment (immediately after birth) the deformity will be rectified. In neglected cases it may be necessary to shorten the tendo Achillis.

Talipes Equinovarus, the commonest form of club-foot, occurs in different degrees. In some cases there is only slight inversion of the foot, with some contraction of the tendo Achillis, so that the foot cannot be flexed beyond a right angle. The most extreme forms show gross deformity, and in neglected cases the child may walk upon the dorsum of the foot. Only those forms which are amenable to simple treatment are considered here ; inveterate or relapsing cases must be treated by osteotomy or other operations, and a consideration of them is beyond the scope of this work.

Treatment consists in : (1) Manipulation ; (2) Splinting ; (3) Tenotomy ; (4) Wrenching.

Manipulation should be started soon after birth, and can be entrusted to the mother or nurse, under supervision. It consists in gently massaging the affected limb so as to make the muscles and tendons supple, and then stretching the foot in the direction opposite to the deformity. In this connection the double nature of the deformity must be borne in mind : first, the varus must be dealt with by pressing the foot over to a position of valgus while the malleoli are steadied with one hand ; and secondly, the dorsum of the foot must be pressed up towards the tibia, so as to stretch the tendo Achillis. These movements must be repeated several times, and it is advisable that at least ten minutes should be spent over them morning and evening.

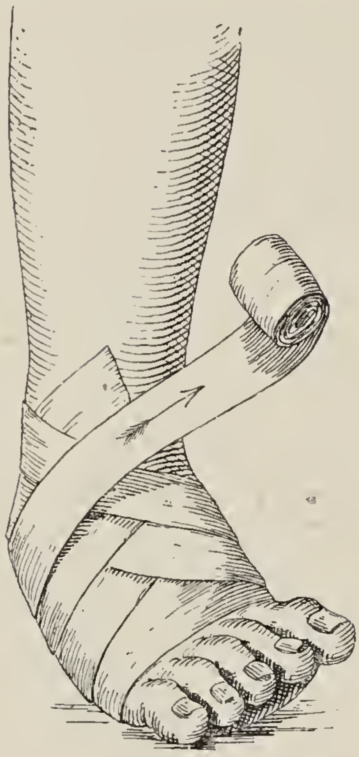
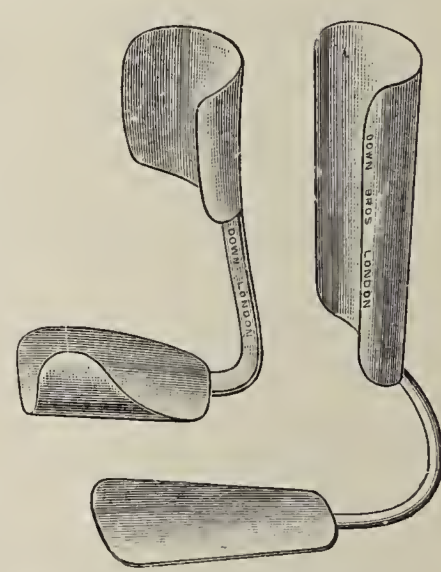


Fig. 200.
Plaster-of-Paris Bandage for Talipes Equinovarus.

Such manipulative treatment is usually combined with *splinting*, which tends to maintain the foot in a corrected position. The three main varieties of splints are: (1) Plaster-of-Paris; (2) Malleable metal; (3) Adams's shoe.

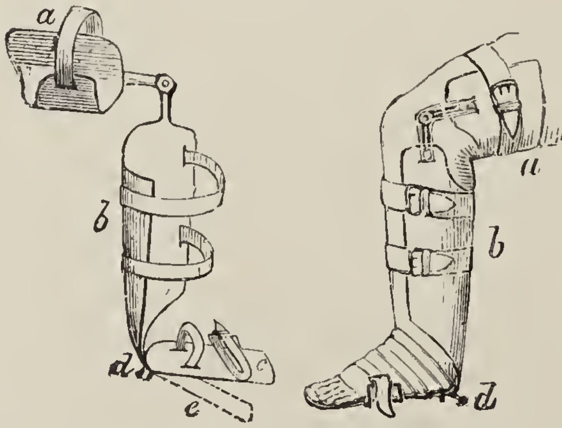
Plaster-of-Paris may be used after operations upon the foot when it is desired to keep the part fixed in a definite position, but it is unsuitable as a routine, since it prevents the regular performance of massage and manipulation, which are essential. It is best applied in the form of a plaster bandage, after a flannel or domette bandage has been wound round the foot and leg (*Fig.* 200).

The Malleable Metal Splint is very convenient. A simple form consists in a strip of metal which can be bandaged to the back of the leg, while the foot fits into a metal trough which can be bent to any angle (*Figs.* 201, 202). The foot is bandaged to this splint in such a way that there is always a certain amount of pressure exerted so as to correct the deformity. This apparatus can be readily taken off and put on by the mother, and is cheap and efficient.



Figs. 201, 202.—Robert Jones's Splints for Talipes.

A Scarpa's Shoe, or some modification of it, is still employed (though not quite so generally as heretofore), more especially in the later stages of the treatment. In *Figs.* 203, 204, a good form of shoe and the mode of its application are shown, and no further description is called for. In all the varieties of this instrument, expense is a great drawback, and it is absolutely essential to have the shoe of the right size.



Figs. 203, 204.—Adams's Modification of Scarpa's Shoe.

The principle of the shoe treatment is to adjust the angles of the instrument to those of the deformity, and then, after fastening the foot and leg firmly into it by straps, to bring the parts into position gradually by turning day by day, but very slightly, the rack and pinion hinges, or other contrivances for altering the direction of the sole (varus) and the angle of the foot (equinus). These shoes will have to be readjusted very

frequently, and the flannel bandage, which should always be put on the limb under the shoe, taken off so that the slightest commencement of a sore may be observed ; these are very apt to form, especially over the heel.

The greatest practical difficulty in this method is the keeping the heel down into its place in the shoe. Unless this be done, every turn of the rack and pinion will only lift it a little more, and no good will be effected. This is a very common oversight, and is of itself a sufficient reason for frequent readjustment.

It will be gathered from the above that the treatment by Scarpa's shoe is a troublesome one, and though success will often repay the daily care required, it will never be a favoured method.

Tenotomy is required in a large number of cases, but it should not be performed until some trial has been given to manipulation and splinting. The structures which may require division are the tibialis anticus and the inner part of the plantar fascia, and the tendo Achillis. It may be necessary to divide the tibialis posticus, the anterior part of the internal lateral ligament, and the abductor hallucis ; but this should not be done until a good trial has been given to less drastic methods, as the foot is considerably weakened by it.

The structures on the inner side—that is, those affecting the varus deformity—should be dealt with first, and the varus be entirely corrected, before any attempt is made to deal with the equinus. If this rule is not observed the results obtained will not be satisfactory.

After tenotomy the foot is put up in the faulty position, if necessary in plaster, and is taken down at the end of four days in order that the position may be changed, the deformity being gradually corrected until it has disappeared ; manipulation and massage being regularly undertaken. It is not advisable to over-correct the deformity immediately after division of the tendon, as such a proceeding causes a big gap to form between the cut ends, and leads occasionally to weakness or non-union of the tendons.

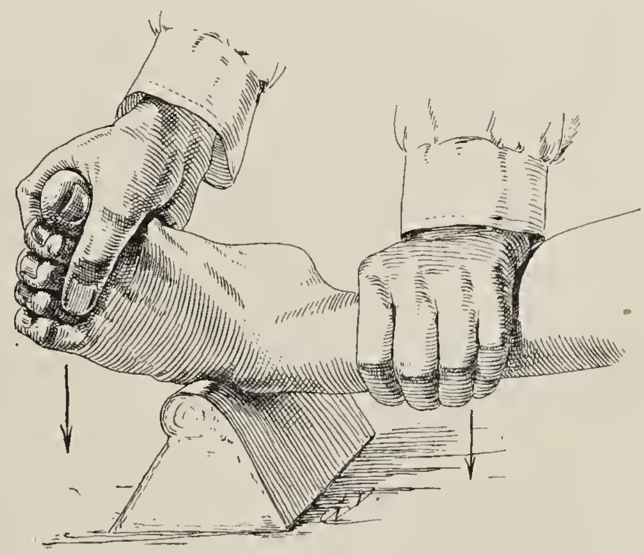


Fig. 205.—Wrenching for Talipes Equinovarus.

Wrenching consists in forcibly stretching the structures on the inner side of the foot or the tendo Achillis, under anæsthesia. It is a useful alternative method to tenotomy in cases of slight deformity, or after tenotomy if there is any relapse. The child is anæsthetized, and the foot is grasped in one hand, the other being used to steady the malleoli (*Fig.* 205). After a little preliminary kneading of the tissues on the inner side of the foot, it is cautiously wrenched until the deformity is over-

corrected. Some fibrous bands will be heard to snap, and there is sometimes considerable ecchymosis after the operation. If ordinary care is taken not to apply undue violence, no harm will result, and the position of the foot is markedly improved ; but if the operator is too energetic or careless, the malleoli may be fractured or the epiphysis displaced. After wrenching, the limb should be splinted for a few days, and then manipulations should be resumed.

In order to obtain satisfactory results in the treatment of talipes, cases must be kept under observation for several years, and great patience be exercised. There is an unfortunate tendency for the deformity to recur, and the child should be fitted with special boots and varus straps as soon as it begins to walk.

Talipes Valgus is a less common form, and can generally be treated by manipulation, a special boot (*see* below) with an outside iron and a valgus strap being ordered when the child begins to walk.

Spurious Valgus.—Flat-foot results from a weakening of the arches of the foot, especially that part supported by the inferior calcaneo-scaphoid or spring ligament. In most cases long hours of standing, faulty-fitting boots, and bad health are responsible for the condition ; but it must be carefully remembered that as the result of infective processes, such as rheumatism or gonorrhœa, the astragaloscaphoid joint may be attacked, giving rise to what is known as 'acute flat-foot.'

In the acute cases the foot should be given rest by means of a splint or a plaster-of-Paris case. It should be put up in a position of varus, so as to over-correct the deformity, while appropriate remedies are applied to treat the primary infection.

Chronic cases should be treated by massage of the foot and posterior tibial muscles, and the patient should be advised to walk and stand on the outside of the foot, and to improve the muscular tone by tiptoe exercises morning and evening.

Proper flat-foot boots should be ordered. These are stout, easily fitting boots, with a firm arch, thicker on the inner than on the outer side, so that the weight of the body is thrown on to the outer side of the foot. Little advantage is derived from pads inserted to support the arch. In more advanced cases the foot should be wrenched into a position of varus, and put up in plaster for a month to allow the ligaments to shorten up, after which the above treatment is to be undertaken.

SECTION VII

OF MINOR SURGERY AND KINDRED SUBJECTS

CHAPTER XXXV

OF THE EVACUATION OF THE SYNOVIAL SACS OF JOINTS AND OF BURSAL AND SEROUS CAVITIES

JOINT EFFUSIONS.

JOINT CAVITIES may become distended with fluid, either through acute or chronic inflammatory effusion, which may be serous or purulent ; more rarely the fluid may be blood, as in a case of fractured patella, or from some much slighter injury in patients with a constitutional tendency to hæmorrhage ; in some of these cases it may be advisable or imperative to relieve the tension within the joint.

These will come under some one of the following heads :—

Acute inflammatory effusion, non-purulent (traumatic or idiopathic) ; *Chronic effusion* (hydrops articuli, or joint dropsy) ; *Hæmorrhage*, always accompanied by more or less inflammatory effusion (traumatic or a symptom of the hæmorrhagic diathesis) ; *Acute suppuration within the joint* (abscess of joint).

Acute Inflammatory Effusion, Non-purulent.— It is very rarely indeed that an idiopathic synovitis causes distention to such an extent that the fluid has to be removed. Rest, cold applications, or massage will usually effect reduction of the effusion, but if these methods fail the joint should be aspirated. In aspirating joint cavities, the needle must always be extremely sharp, have been sterilized by boiling, and the spot of puncture have been very carefully washed with antiseptic before operation.

In cases of effusion arising in consequence of *injury*, it somewhat more frequently occurs that the internal tension is so great that it is right to prevent permanent damage, through the softening of the ligamentous structures about the joint, by removing the fluid. This is always done by aspiration, as above mentioned.

Chronic Effusion.—In cases where the quantity of fluid is large, where the signs of inflammation are absent, and when the ordinary measures for producing absorption have failed, recourse has been had to aspiration followed by pressure, or to tapping ; but the injection of stimulating fluid is not recommended, as, though in some cases improvement has followed, serious results have been known.

Hæmorrhage.—In cases of very severe injury to a joint, as, for

example, that which is inflicted on the knee-joint in some cases of fracture of the patella, the joint may become greatly distended with blood as well as with inflammatory effusion, and the tension here also may be so great as to call for aspiration, as was mentioned when we were considering that fracture. If it be adopted, a somewhat larger cannula or needle will be required than for the removal of simple serum. The same antiseptic precautions must be followed.

Patients who are examples of the hæmorrhagic diathesis, either in the shape of hæmophilia or purpura, or who are attacked with scurvy, may have almost spontaneous effusion of blood into their joint cavities. In these cases no operative interference is ever called for, and the effusion must be left to be absorbed by natural means.

Acute Suppuration within the Joint.—But when in *acute arthritis* the local and constitutional signs point to the presence of *pus* in a joint, the line of treatment differs in almost every particular from those we have been discussing. Now, every hour's delay in affording relief is dangerous, and the only treatment that can be advised is laying the joint open freely, and thoroughly irrigating the cavity. (Murphy advised the trial of 2 per cent formalin in glycerine, of which 2·3 drachms were injected into the joint. The solution must be made up twenty-four hours before use.) Before, however, proceeding to such a serious operation it is as well to insert a hypodermic needle of large size and withdraw some of the fluid, to make certain that pus is present. Tapping with an ordinary trocar is attended by more risk of damaging the joint cavity, but in the case of turbid synovia it is sometimes necessary to use this instrument, as the thick fluid may not be able to flow through an aspirating needle.

If a joint is to be freely opened, this must be done by such incisions as will secure drainage and a free passage for lotions, etc. The presence of any symptoms of septicæmia is an additional reason for opening and freely draining the joint, and the injection or syringing out with some antiseptic fluid. In all cases the joint must be kept carefully splinted, and great attention must be given to its position, which should be that of the greatest use to the patient should ankylosis ensue. As a rule, the joint cavity, and the abscesses which are apt to form in its neighbourhood, will have to be washed out very frequently.

Wilms has shown that the use of tubes to drain infected joints is, to say the least, very unsatisfactory, and has advocated " mobilization " of the infected articulation. He argues that movement not only prevents ankylosis but encourages drainage through the opening made in the synovial membrane. The method is not applicable to the most acute cases, but with careful selection it is an admirable method of treatment for subacute infections, especially of the knee-joint. (The reader should look up Wilms's article on this subject.)

Suppuration inside a joint also occurs in the later stages of chronic arthritis, calling for relief by incision—hardly ever by aspiration. The necessity for relief is not in these cases so urgent, but in all other

respects their management is similar, although the prognosis is much less hopeful.

We have hitherto considered the question of evacuation of joint cavities as applying to all joints, but it is the knee which is especially apt to become acutely inflamed, or dropsical, or in which there is found blood, or acute suppuration. We must therefore consider particularly the exact methods of aspiration and incision of the knee, although we need not do so in the case of any other articulation.

Aspiration of the Knee-joint.—The spot where the synovial membrane of the knee-joint comes nearest to the surface is on the inner side, at the level of the lower border of the patella, and the aspirating needle should be plunged thereabouts into the place where fluctuation seems to be most distinct, entering the cavity of the joint at right angles to the skin surface, which has been carefully washed with soap and water and some antiseptic fluid. Gentle pressure should be made upon the part as long as any fluid escapes, and when the cannula is withdrawn, a very small pad of lint soaked in collodion may be placed on the spot as a precautionary measure. If the needle be one of the fine ones generally used in aspiration, this pad is hardly necessary, but if a larger trocar and cannula be used it should never be omitted. Whatever instrument is used should be well boiled, in order to render it aseptic.

Incision of the Knee-joint.—If one opening only be made, this will almost always be on the inner side ; but as a rule a counter-opening is also deemed advisable, to secure thorough drainage, and the readiest way to get into the joint on the outer side is to make the inner incision first, and then to pass a probe or director across the interior of the cavity until it can be felt beneath the skin, and can there be cut down upon.

BURSAL EFFUSIONS.

Enlarged Bursa Patellæ.—It frequently happens that this bursa, as well as others, is the subject of chronic enlargement, from accumulation of fluid within. In some cases this may be absorbed by the action of iodine, blisters, etc., or by steady compression or strapping. But very frequently it will be necessary to evacuate the glairy or gelatinous contents of these sacs. The best method is to open the cavity with a sharp double-edged knife. When the sac is emptied and the contents are thoroughly evacuated, the incision may be stitched up for two-thirds of its length, and a strand of catgut left in for drainage. Firm compression with a pad and bandage must be maintained, and it will generally be wise to restrain the movement of the part by means of a splint. Thus, in the case of an enlarged bursa patellæ, or 'housemaid's knee,' a back splint for the knee-joint should be applied. At the end of a week or ten days, provided the antiseptic precautions have been efficient, the wound will be found to have united, and the catgut strand will have been absorbed, except that part outside the wound, which will come away with the dressing.

In cases where the bursal wall is very much thickened, it is usually necessary to dissect out the bursa ; this should be done through a vertical incision, and the knife kept close to the bursal wall, in order to avoid wounding the knee-joint.

Simple Ganglia are small nodules which vary in size from that of a pea to a walnut. They are usually found on the back of the wrist in connection with the extensor tendons, but they may arise in other situations. They are the products of collagenous connective-tissue degeneration—probably the result of trauma—and though they may communicate with the synovial membranes covering tendons or lining neighbouring joint cavities, such communications are secondary.

1. *Counter-irritation with Pressure.*—The swelling should be painted with iodine liniment, and firmly bandaged or strapped. In a certain number of cases this will be successful.

2. *Puncture.*—A tenotome is inserted beneath the skin, with due regard to the anatomy of the part, and the swelling is freely incised, a valvular opening being made. Pressure is then exerted over the swelling, so that its contents are extruded. A collodion dressing is applied with firm pressure, so that the walls of the cavity are brought into apposition. It is better to allow the gelatinous contents of the ganglion to escape externally than into the cellular tissues, and the whole proceeding must be conducted under the most careful asepsis, or very serious, even disastrous, results may occur.

3. *Excision.*—When a ganglion resists the above methods of treatment, or when the surgeon and patient both desire a speedy cure, the ganglion may be exposed by a free incision and dissected out. The tendon sheath, or sometimes a joint cavity, may be opened, but if absolute asepsis is maintained there is no danger. Subsequently, early movement of the part must be undertaken to prevent the tendon from becoming fixed by adhesions.

As these ganglia are very mobile, they should be steadied with the fingers of the left hand while the puncture is made and until the sac is empty, otherwise the operator may have a little trouble in getting into the sac.

Compound Ganglia, such as those which often extend beneath the annular ligament at the wrist, are much more serious, and frequently contain 'melon-seed bodies.' The best way to treat them is by vertical incisions above and below the annular ligament, whereby the cavity must be thoroughly irrigated. It is usually well to drain for a couple of days, the hand and arm being kept on a splint.

EVACUATION OF SEROUS CAVITIES.

The serous cavities of the pleura, peritoneum, and the tunica vaginalis testis are frequently the seat of fluid accumulations which have to be removed by aspiration, tapping, or incision, and the methods of the evacuation in each case must be considered separately.

Paracentesis Thoracis is a simple enough operation, if the physical

signs of the presence of fluid are distinct; but if there be any doubt on that point, or if the pleura has to be punctured in an unusual place, it will be safer first to insert a fine exploring aspirating needle, the most convenient instrument being an ordinary hypodermic syringe.

Aspiration is generally the method chosen when the fluid is believed to be serum, or when the pleural cavity is to be emptied for the first time. The ordinary pattern of the instrument is shown in *Fig.* 206, and its management is described on p. 273. The place of election for the insertion of the needle, and for all other punctures and incisions into the pleura, is either in the mid-axillary line in the middle of the fifth or sixth interspace, or, if an opening further back be required, in the seventh or eighth interspace, just in front of or behind the posterior axillary line. The needle or fine trocar must be very sharp, and must be inserted with a 'stab' so as to avoid pushing forward any false membrane adhering to the parietal pleura The patient should lie as low as the performance of the operation will allow, and, if faintness ensue, it will be necessary to stop the evacuation for a time. The fluid should be drawn off very slowly.

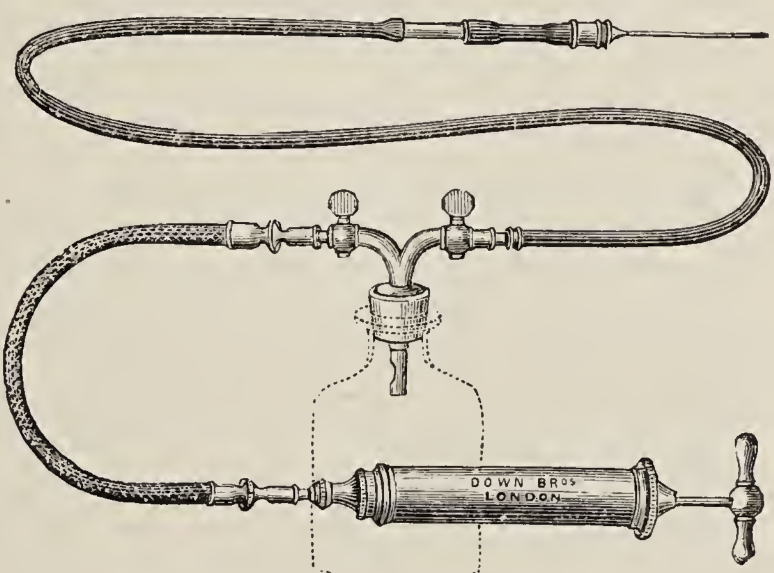


Fig. 206.—Aspirator, with Bottle.

The aspirator has displaced the old trocar and cannula to a great extent, but the latter instrument is still frequently employed. It is desirable, when a trocar is used, to have some arrangement by means of which air shall be excluded from the chest cavity during the operation.

The tube having been attached, the trocar is inserted as the aspirating needle was, and the cutting piston is immediately withdrawn into the handle, so that the fluid passes down the side branch and down the tube, which acts as a syphon.

It will often happen that the aspirator or trocar will draw off healthy serum, and that the operation will not need to be repeated, or at least only once or twice, the fluid remaining serous throughout. But if the evacuation has to be often repeated, pus is almost certain to be formed, while in other cases it may be present from the first. Should this be so, we have now to do with an empyema instead of a serous pleurisy ; and it will be necessary to evacuate the pus.

Operation for Empyema.—The collection of pus in the pleural cavity, called an empyema, may be treated in three ways, each

method being required according to the special needs of the case: (1) Aspiration; (2) Incision through an intercostal space and drainage; (3) Excision of a portion of a rib, and drainage through the larger space thus afforded.

1. *Aspiration* is the method of choice in cases where an active pneumonia is coexistent (synpneumonic empyema): *indeed, thoracotomy must not be attempted* at this stage. It may be either intermittent or continuous. *Intermittent aspiration* is done by Potain's apparatus, the chest wall being locally infiltrated with 0·5 per cent novocain or gas and oxygen administered. The pleural cavity is emptied as completely as possible and the puncture sealed. *Continuous aspiration* is done by puncturing the pleura with a trocar and cannula. The cannula is fastened to the chest wall by strapping and the trocar is withdrawn. A rubber tube larger than the bore of the cannula is introduced through it by stretching over a rod, so that when the rod is withdrawn the tube fits the cannula tightly enough to be air-tight. The tube is then fitted to a water-drip suction apparatus, e.g., a Sprengel's pump, and the fluid collected in a bottle.

2. *Incision* is often the ideal method if the case is operated on early enough, and it is certainly the method of choice if the patient is very ill.

If the pathological condition is considered, it will be obvious that however thoroughly the pleural cavity is drained, some infection must be left behind, which the pleural membrane can deal with as the peritoneum does in peritonitis. If a case is drained early, before the visceral pleura has become markedly thickened, the lung has a chance to expand and to fill the cavity occupied by the pus. If incision is combined with aspiration drainage, the lung has a better chance for expansion, and it is certainly a method to be practised, many cases recovering by this treatment alone. If necessary it is easy to have recourse to exeision of a rib; but to practise this procedure in every case, and especially in early cases, seems too drastic.

Incision is of service in empyemata in children, or if the patient's condition prohibits more than local anæsthesia or general anæsthesia of very short duration.

The operation can be performed very quickly by incising the skin over the seventh intercostal space in the posterior axillary line, and completing the operation with the knife or sharp-pointed scissors. If the latter are used, they are thrust into the pleural cavity through the intercostal muscles, and then opened, all danger of injuring the intercostal vessels being avoided if the instrument is kept near the *upper* border of the rib. If the knife is preferred, it is thrust into the pleural cavity in the same manner, cutting through the muscles anteriorly as it is withdrawn. The opening is then enlarged with sinus or artery forceps, and a stout tube (a Pezzer self-retaining catheter is excellent for the purpose), which will better withstand the compressing influence of the ribs, is inserted into the cavity, and

a dressing applied. The position of the patient should be the same as that in the following operation.

Excision of Rib.—This operation may be done under local anæsthesia, but it is better performed under a general anæsthetic. If the condition of the patient is such as to render local anæsthesia advisable, incision only is preferable. The patient should lie on the back, with the shoulder and thorax of the affected side drawn well over the edge of the bed or operating-table ; the eighth rib is defined, and a point is taken along it just in front of the post-axillary fold formed by the latissimus dorsi—that is, in the posterior axillary line.

Three precautions are to be observed in opening empyemata :—

1. Not to make the incision too far forward, or the empyema will not drain satisfactorily.

2. Not to place the incision so that the inferior angle of the scapula will come into contact with the drainage tube : an accident which may happen if the incision is placed too far back.

3. Not to make a valvular opening through the skin.

As the arm is usually raised to the level of, or above, the patient's head, the skin is stretched and the angle of the scapula is brought forward, and these displacements must be kept in mind when the incision is made. The skin should be gently drawn down over the eighth rib, and an incision two inches long made straight down to the periosteum. This should be carefully and thoroughly lifted from the bone by suitable raspatories, and the inner surface of the rib should be cleared in a similar manner with Doyen's curved periosteal elevator (*Fig.* 207). The rib is cut through at each extremity of the incision by means of strong forceps, and 1 to $1\frac{1}{2}$ in. of bone are removed. The periosteum on the deep surface of the rib is now exposed, and a pair of sinus forceps —or if the empyema is of long standing, a pair of sharp-pointed scissors—is thrust through the middle of the periosteum and pleura into the cavity of the empyema. If these precautions are observed, the intercostal vessels which are here lying in the subcostal grooves will escape injury. Should they be damaged they should be secured by passing a curved needle armed with a ligature round them. As soon as the pleura is opened, the pus rushes out and the air rushes in, and at this point the patient's condition may become serious. The pus should be only allowed to come out slowly, and the affected side of the thorax should be firmly compressed by an assistant, so as to lessen respiratory movement. Severe syncope is treated at once by the injection of strychnia, 5 min., and by inhalation of oxygen.

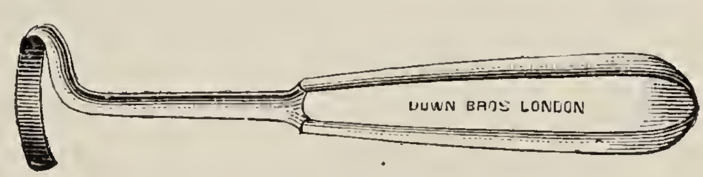


Fig. 207.—DOYEN'S RASPATORY.

A finger should be introduced into the cavity so as to remove the masses of lymph, which retard expansion of the lung, and which often interfere with drainage. A large scoop is of great service for this

purpose. Finally, a large-sized drainage tube, provided with a broad flange (*Fig.* 208) to prevent it falling into the pleural cavity, and of a length just sufficient to enter the pleural cavity, is introduced, and a firm dressing is applied.

The cavity should never be washed out at the time of operation —later it may be advisable to irrigate it with a weak solution of iodine, or to make use of the Carrel-Dakin method ; there is always a risk of syncope following any injection into the pleural cavity.

The dressings should be frequently changed, and the tube should be removed as soon as possible ; this can sometimes be done from the fourth to the sixth day, since the pleura, like the peritoneum, is capable of more active repair than other tissues.

The long-continued presence of the tube is the cause of sinus formation and chronic irritation, but in some cases it must be retained for a much longer time. In this respect each case must be treated on its merits, but it may be removed before all the discharge has ceased, *provided the lung has expanded,* since any healing or granulating surface continues to discharge, especially in the presence of a drainage tube.

Empyemata must be treated with the most careful antisepsis. Rarely is the infection a mixed one. The pneumococcus is present in the majority of cases, and if other micro-organisms are kept away, healing is carried out in a satisfactory and rapid manner. The cause of persistent sinus after operation may be due to the empyema being of long standing—the great thickening of the pleura preventing the lung from expanding ; but in many cases it is surely due to careless after-treatment.

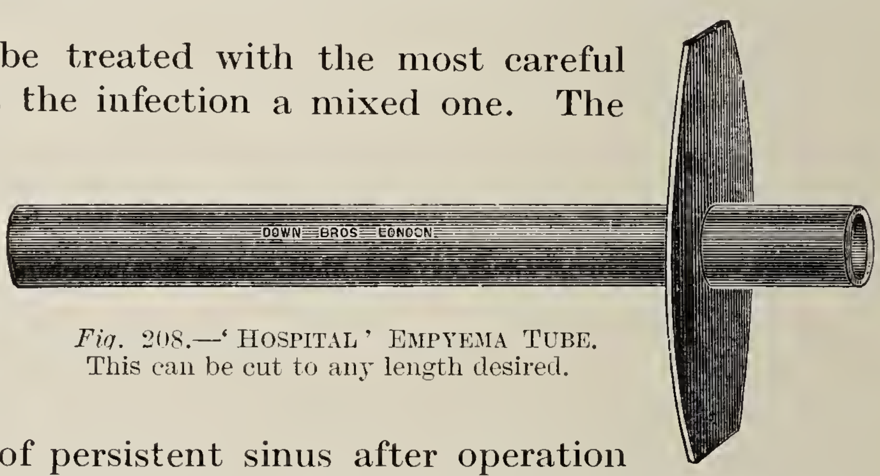


Fig. 208.—‘ HOSPITAL ’ EMPYEMA TUBE.
This can be cut to any length desired.

During convalescence the patient should be encouraged to exercise the lung of the affected side. This may be done by turning him on to the sound side of the chest, and making him breathe deeply, thus expanding the affected lung. Toy trumpets and balloons should be given to children for the same purpose.

The above descriptions apply to generalized or extensive empyemata ; when the collection of pus is strictly localized, the rib must be removed which gives best access to the cavity. But the above precautions should be observed.

Empyemata that fail to heal can be well treated by the Carrel-Dakin method: there is little danger in the irrigation, provided a free exit is afforded to the irrigating fluid.

Pneumo- and Hæmo-thorax.—As the result of injury or disease the pleural cavity may be filled with air or blood. The natural tendency in both instances is for absorption to take place without

any active treatment being required; but if there is great interference with respiration, owing to the extent of the accumulation—the patient becoming cyanosed and suffering from urgent dyspnœa—or if the heart is greatly displaced, the pleural cavity should be aspirated and the pressure reduced. Of course the greatest possible care must be taken to keep everything aseptic, or serious complications will be the result.

If a hæmothorax becomes infected it must be treated by free opening and drainage. Owing to the adherent character of the clot it is often very difficult to dislodge it, and a very free opening may be required.

Air can be withdrawn very satisfactorily by means of Potain's aspirator, and in many cases, owing to the wound in the lung healing, it does not reaccumulate

Paracentesis Abdominis is a more simple operation than that for the evacuation of the pleural cavity. The spot chosen is almost always midway between the umbilicus and the pubes, and exactly in the middle line. Before tapping, the bladder should be emptied, if necessary with a catheter. The patient should be placed half sitting up in bed, and a very broad flannel bandage, or some form of binder, must be so adjusted that it can be tightened up from time to time, to give support to the abdominal walls and contents, as the fluid is removed.

Draining by Trocar and Cannula.—A simple full-sized instrument may be used, but a much more convenient pattern is the 'piston trocar,' with a side branch for a tube. If the puncture is made exactly in the mid-line there is very little pain connected with it. The direction of the puncture should be backwards and slightly downwards, for as the abdomen diminishes in size, the trocar will alter its position, tending to point more and more upwards and away from the fluid.

The fluid should be received into a bucket placed on the floor by the side of the bed, and, as we have said, the abdominal walls must be carefully supported throughout the operation. The patient must be watched, lest faintness should come on, and will often require a little stimulant. If necessary, the flow of the ascitic fluid may be stopped by raising the tube above the level of the abdomen till the faintness passes off.

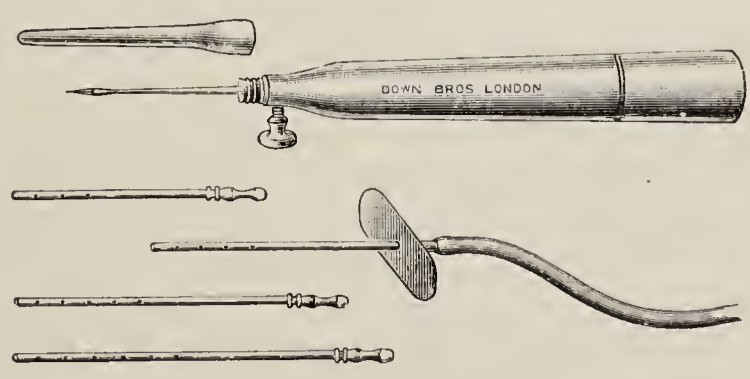


Fig. 209.—Southey's Fine Trocars and Cannulæ.

By a Southey's Trocar.—Another way of draining ascitic fluid is to employ one of Southey's trocars (*Fig.* 209). These trocars with their ensheathing cannulæ are made as fine as possible, and can be connected with a specially fine kind of drainage tube. The insertion

of these small instruments is practically painless, and is performed in the same place and direction as the larger ones. The trocar and cannula may be inserted, and the trocar withdrawn after the usual manner of using this instrument, the tubing being then slipped over the protruding end. But as the end and the tube are both small it is sometimes a little difficult to do this. A side branch has been suggested as an improvement in this respect, but this is not at all necessary, for the difficulty is quite overcome if the tube be attached beforehand to the empty cannula, and the trocar be then thrust into it, piercing the tube first at a very little distance from its end. When the trocar and cannula have been inserted in the tissues, and the trocar is withdrawn, it will be found that the small puncture which has been made in the indiarubber tube closes of itself. The tube is said to deliver the fluid at a rate of from ten to twenty ounces per hour, so that there is no sudden disturbance of the visceral relations, and no necessity for swathing the abdomen in any form of binder.

Anasarca.—These trocars were originally introduced by Southey for a different purpose, namely, for the relief of severe and tense anasarca—a condition which may here be conveniently considered. In the great majority of cases of serous effusion into the cellular tissues, elevation and the removal of all obstruction to the venous circulation will be all that is required, and if the œdema be more obstinate than usual, it may be diminished by bandaging, and more especially by the use of Martin's rubber bandage. But sometimes the distention of the parts is so great that the skin is stretched even to bursting, and a peculiar form of superficial gangrene, combined with a condition of erysipelas, may develop.

Under these circumstances it becomes necessary to relieve the tension by removal of the fluid, and this was commonly done by making numerous stabs or minute incisions with a small scalpel from which the serum could drain away. The objections to this proceeding were that the limbs affected (usually the legs) were forced to remain wrapped up in sloppy clothes, and that the skin, bathed in the exuded serum, soon became sodden. Moreover, it not infrequently happened that the punctures themselves became the starting-point of troublesome sores

These objections are all met by the use of the fine cannulæ above mentioned. Three or four of these may be introduced into the dropsical parts by means of the trocar, and then the serum which escapes through them may be conducted away from the bedclothes by the indiarubber tubing.

The tubes should be of sufficient length to discharge the fluid into some vessel below the bed.

The cannulæ should be introduced at right angles to the surface ; they should fairly enter the cellular tissue, and on withdrawal the puncture should be covered with a pad of wool secured by collodion.

Great care must be taken to keep the instruments scrupulously clean, and they should always be well boiled before they are used.

Hydrocele of the Tunica Vaginalis.—The treatment of this condition may either be palliative, remedial, or curative. Thus, it often occurs that a moderate-sized hydrocele may remain stationary for years, giving little or no trouble, provided only that the scrotum is properly supported by a suspensory bandage.

But in most cases the serous effusion will sooner or later accumulate to an extent which produces discomfort or pain, and very frequently the sac takes only a short time (that is, one to be measured by weeks) to fill. The remedy in these cases is to remove the fluid by tapping, whenever and as often as it causes inconvenience by distention. Although it very rarely happens that the fluid does not reaccumulate, still most patients are thus enabled to escape any real disablement.

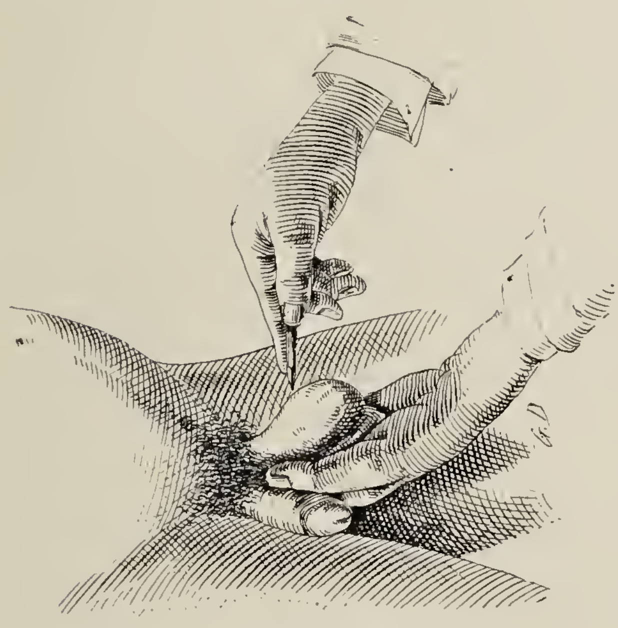


Fig. 210.—Tapping a Hydrocele (*right way*).

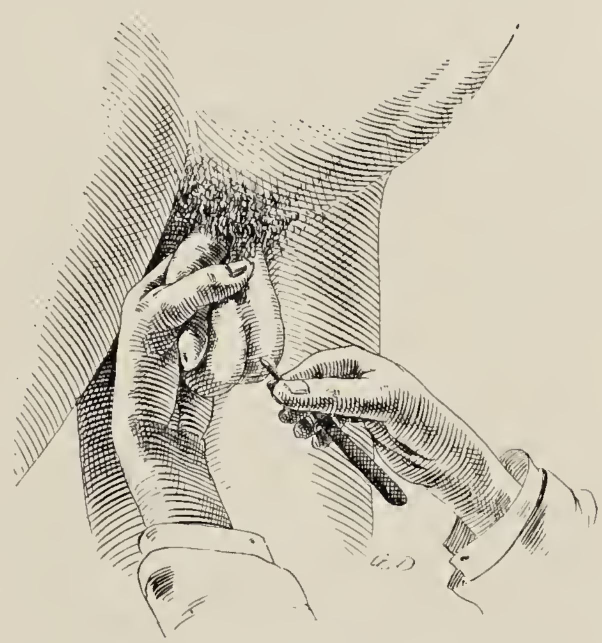


Fig. 211.—Tapping a Hydrocele (*wrong way*).

Tapping a Hydrocele.—In deciding whether the right time has come to tap a hydrocele, attention should be given rather to the tenseness of the sac than to its size. It is always wise to wait until it is fairly full, not only because the operation is then easier, but because the intervals between the tappings should be as long as possible.

No surgical operation would seem to be easier than this one, and in truth it is as easy as it seems to be. Yet even here there is a right and a wrong way, and the wrong is often chosen.

The points to be looked to are, that the testicle be protected from injury, that the skin of the scrotum and the sac be made tense and prominent in front, and that the cavity be entered with one stab of the trocar, the veins of the scrotum being avoided, and the depth of the plunge being regulated beforehand by the position of the finger on the trocar. *The patient should be lying down on a couch.*

Most of these points are shown in *Fig.* 210, where the left hand is

seen to be making the tissues tense in front, and at the same time receiving and protecting the testis behind, while the forefinger of the right hand steadies the trocar and serves as a shield, so that it cannot be pushed in too far.

In *Fig.* 211, on the contrary, some of the common faults committed in tapping are illustrated, such as the oblique position of the trocar (which may never enter the sac at all), the left hand pushing the testis downwards and forwards, etc. Before the trocar is introduced, an effort should be made to locate the testicle, either by allowing a strong light to shine through the hydrocele, when the testicle can often be seen as a dark crescentic body, or by getting the patient to locate it himself. The mere fact that the anterior part of the sac can be clearly transilluminated is satisfactory evidence that the testicle occupies its normal position at the back of the sac. The skin of the scrotum is to be carefully cleaned.

The trocar commonly employed is shown, half size, in *Fig.* 212, but smaller ones, down to a fine exploring trocar, may well be used. During the time that the fluid is escaping, the cannula should be steadied with the left hand, or it may slip out of the opening in the sac, with the result that the fluid escapes into the tissues of the scrotum, and produces an œdema which is somewhat alarming in appearance. When all the fluid that will escape has been drawn off, the cannula must be withdrawn, and unless a needlessly large instrument has been used, there will be no necessity for considering the wound, though it would be safer to fasten on some aseptic wool with collodion. A suspensory bandage should be worn from the first.

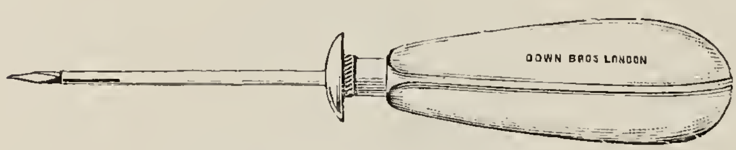


Fig. 212.—Hydrocele Trocar.

So far as the tapping is concerned, the directions given above for the ordinary hydrocele will apply almost equally to any of the various cystic accumulations which are common here (such as hydrocele of the cord, spermatocele, etc.), and we need not consider them further.

The commoner complications which result from tapping are :—

Hœmatocele—usually from an injury to the testicle ; occasionally from a scrotal vein.

Sloughing and suppuration from the use of dirty instruments, though occasionally from the patient's constitutional debility.

Failure to strike the fluid is nearly always due to bad technique.

If a hæmatocele occurs it should be treated by the application of an ice-bag or evaporating lotions, and the patient should rest in bed for a day or two.

The tapping of collections of fluid in the tunica vaginalis is also of use for diagnostic purposes. An old hydrocele is often mistaken for a new growth, and *vice versa.* If an exploratory puncture is made with a small trocar and cannula, valuable information may be obtained.

From the old hydrocele dark blood, loaded with cholesterin crystals, can be obtained, but from a new growth which has ruptured into the cavity of the tunica vaginalis, or which is still confined by a stretched tunica albuginea, bright red blood will flow.

Hydroceles in children rarely require any very drastic treatment. If the hydrocele is of the congenital type, a free communication existing between the sac and the peritoneal cavity, a truss should be applied in the hope that adhesions will form at the region of the internal abdominal ring, thus converting the congenital to the infantile type. The infantile form, which is shut off from the peritoneal cavity, and the ordinary scrotal form, are best treated by multiple punctures with a sharp Hagedorn needle ; the fluid escaping into the cellular tissue is absorbed. A compress soaked in lead lotion should be applied.

Injection for Hydroceles.—This method of treatment is less frequently used, owing to the more certain results obtained by the open operation.

The Radical, or **Open Operation,** which is much in favour at present, since it offers the most certain prospect of cure, consists in making an incision through the coverings of the scrotum, opening the tunica vaginalis and allowing the fluid to escape, and then dissecting away the parietal serous membrane up to the point where it is reflected on to the testicle and epididymis. Although a simple procedure, certain precautions must be observed.

Not only is the tunica vaginalis thickened in old-standing hydroceles, but the other coverings of the scrotum share in the change. The result is that there is often a sac a quarter-of-an-inch thick covering the walls of the hydrocele cavity. As it is the *serous* layer that secretes the fluid, this layer alone requires removal, and an attempt should be made to separate it from the other thickened layers, so that the tissue removed is as thin as possible. If this cannot be done, the thickened tunicæ must be cut away ; but every vessel must be carefully tied. Moreover, it is advisable to sew round the cut edge with a fine continuous catgut suture, so as to check any bleeding. The vessels in the thickened layers are numerous though small, and they cannot retract owing to the chronic inflammatory thickening.

No adequate pressure can be applied to the scrotum ; hence the common complication after operation on hydroceles is to find the whole cavity distended with blood-clot, a complication which often necessitates a late visit to the theatre in order that the clot may be turned out. This accident can be prevented by attention to the above details, and by the employment of a good-sized drainage tube for twenty-four hours. The tube should be the size of a cigarette ; smaller sizes get blocked by clot and are useless. It should be placed in the upper end of the incision, as after operation the scrotum will be kept up on a pillow. Drainage is not required in small hydroceles, nor in those cases where the sac is thin and avascular.

CHAPTER XXXVI

OF THE USE OF CATHETERS AND OTHER INSTRUMENTS IN THE BLADDER

IN this chapter we shall consider, first, the chief practical points which arise in connection with the passage of instruments along the urethra into the bladder; next, the methods of emptying the bladder of its contents by aspiration or by tapping, and of washing out the bladder and urethra; lastly, certain complications, such as retention and suppression of urine.

Use of Catheters, Bougies, etc.—The passage of a catheter may be required for the relief of *retention*, whether arising from spasm, stricture, or enlarged prostate, or from an atonic or paralytic state of the bladder walls; or from a combination of several of these causes. It may also be necessary both for the prevention of extravasation and the relief of retention in cases of injury to the urethra (and sometimes in rupture of the bladder), and later, for the prevention of traumatic stricture.

Catheters or bougies are also employed for the *cure of strictures* by mechanical dilatation, and both the metal instruments, and what are known as *medicated bougies*, are employed in disorders of the urethral mucous membrane, such as gonorrhœa. Again, catheters are used for the systematic emptying of the bladder, and for the introduction of lotions (' washing out ' the bladder) to improve the condition of its mucous membrane; and those of a very large size are employed to remove calculous débris after lithotrity, and, more rarely, blood-clots.

Lastly, catheters or bougies are frequently used as guides to the position of the urethra, or of strictures within it, in various operations.

Sounds, on the contrary, are used purely for diagnostic purposes; while *staffs* are directors of various shapes and curves, which possess a deep groove, along which a cutting instrument may be passed for the incision of a urethral stricture, or for entrance to the bladder. There are, moreover, many other instruments, such as internal urethrotomes, urethral dilators, galvanic bougies, etc., the purposes of which may be known from their names. With the majority of urethral instruments we have here nothing to do, and we have therefore only to treat of the actual manipulative proceedings which are necessary for the skilful passage of catheters or bougies.

OF THE DIFFERENT KINDS OF CATHETER.

The ordinary **Silver or Plated Catheters** are too well known to require description. They, as well as the flexible ones, are made in

England and America in sizes from $\frac{1}{2}$ up to 12 or 15, or even larger, according to an arbitrary gauge (*Fig.* 213). In France a more systematic plan is followed, the numbers of the instruments corresponding to their circumference in millimetres, No. 1 being 1 mm. round, No. 5, 5 mm., and so on. This principle gives more numerous subdivisions ; thus there are eighteen numbers (3 to 21) between the twelve ordinary English ones (1 to 12).

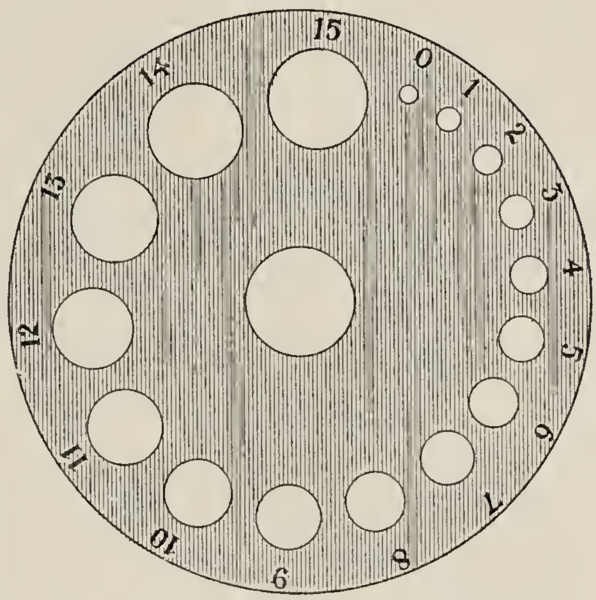


Fig. 213.—English Catheter Gauge.

With regard to the curve, the standard is commonly called 'Brodie's,' but many surgeons prefer to have their instruments curved according to their own ideas. *Prostatic metal catheters*, to which we shall again refer, are also generally named after Brodie. They differ from the ordinary ones in being both longer and much more boldly curved. The curve, too, should extend quite to their extremity, which is not always the case with the others (*Figs.* 214, 215).

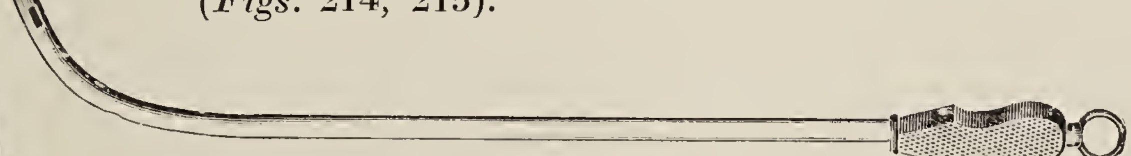


Fig. 214.—Ordinary Silver Catheter.

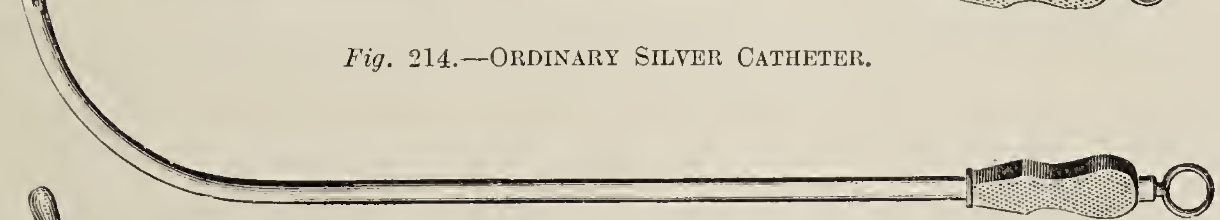


Fig. 215.—Prostatic Silver Catheter.

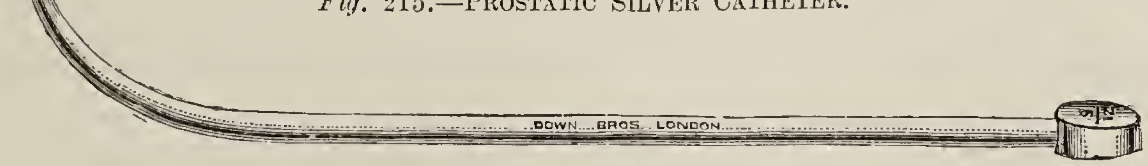


Fig. 216.—Lister's Steel Bougie.

Metal Bougies or solid instruments are of the same shape and gauge as catheters.

Lister's Bougies will often be found of great service in dilating a stricture ; they differ from the ordinary bougies in that they taper towards the point, which is three sizes smaller than the shaft. The passage of the point through the stricture ensures therefore the passage of the shaft of the bougie, and each in this manner prepares the way for the larger size which is to follow (*Fig.* 216).

Flexible Catheters are of several kinds, but the principal ones

are made of 'gum-elastic' and of india-rubber. Celluloid has also been used. Gum-elastic catheters are made of some preparation of gum resins, incorporated into the meshes of a woven tube, which is made of silk or linen thread.

There are two chief kinds of these *Gum-elastic Catheters*, each made in several qualities. In the older kind the woven basis is stiffened by gum resins, and varnished, so that the instrument is yellowish red and shows the meshes of the silk or thread. These catheters are flexible when heated, but tolerably stiff when cold. A wire stylet of the ordinary catheter curve, or of any other which may be desired,

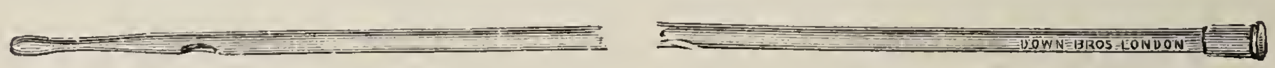
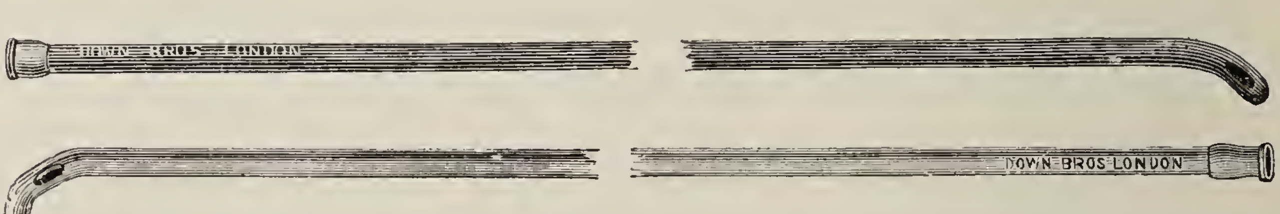


Fig. 217.—Olivary Gum-elastic Catheter.

is generally placed in their interior, the shape of which they will retain after it is withdrawn, even when rendered moderately flexible by warming. With regard to shape, this kind is always uniformly cylindrical, like the silver catheters.

The other kind is now in much more general use, and many forms of catheters, differing especially as to the shape of their ends, are made in it. These are the 'black, soft catheters,' originally of French manufacture, the employment of which is becoming much more general as compared with metal instruments. They, like the first kind, have a woven basis, into the meshes of which some resinous preparation is incorporated, but they are much more flexible, and have nearly superseded the older make.

They are sometimes made uniformly cylindrical, but more generally terminate in some special shape, designed to facilitate their passage. Of these the *bulbous* (*à boule*) or olivary (*Fig.* 217) is the favourite with most surgeons.



Figs. 218, 219.—Elbowed Catheters. (Catheter Coudé and Bicoudé.)

The elbowed catheter again (*Figs.* 218, 219) is often extremely useful, especially in prostatic cases, as will be directly explained.

A good gum-elastic catheter can be easily tied up in a knot without any cracking of the surface, and when its point is pressed upon with the finger, it should bend easily over in a uniform curve, and should not give way in an angular fashion at the eye. Care should also be taken, if the instrument be a small one, that it is properly pervious. The eye should be clear, with perfectly smooth edges; and, inasmuch as it is at this place that cheap, badly made instruments give way, special attention should be given to the condition

of this opening, and the catheter should be broken and discarded if any crack or flaw be there discovered. The end of the catheter below the eye should be *solid.*

Pure India-rubber Catheters are of two or three varieties, the most useful being that known as 'Jacques',' which is of great value from its perfect softness and flexibility. It is made of a red rubber, and is employed in cases where an instrument has to be left in the bladder, or where the patient has to pass one for himself.

Solid Bougies are made of the same shape and size as the hollow catheters in both the gum-elastic materials, and the two kinds differ from each other in respect of flexibility in just the same way.

'Bougies' proper, i.e., instruments made of wax, with some woven basis, are now rarely used; introduced before the virtues of india-rubber were appreciated, they were then almost the only kind of flexible instrument possible, but they are now unnecessary and inconvenient. Wax may be used, however, as the vehicle in some forms of medicated bougies.

Two other forms of bougies should be mentioned, namely, those made of whalebone and of catgut. They are both very useful in difficult cases, where the finest instrument can hardly be passed. This is especially true of catgut, which may with patience be made to traverse very tortuous paths. They are sometimes moulded into a twisted or corkscrew form.

GENERAL POINTS IN THE PASSAGE OF ANY URETHRAL INSTRUMENT.

There are some points common to the passage of all forms of catheters, and to a large extent of bougies also, which may be enumerated before we describe more particularly the passage of metal and flexible instruments respectively.

1. **As to Size.**—It may be laid down as a rule almost without an exception that in any given case the catheter which *should* be used is the largest which *can* be used, within the limits of the normal calibre of the urethra, so that in cases where there is no narrowing of the canal itself, a full-sized instrument, No. 10–12, should be chosen; and when there is a narrowing, as in strictures, the practice should be to work downwards from instruments which are too large, until one which will pass is reached; not upwards from those which are too small, to the same point. The reason for this rule is that, other things being equal, the smaller the instrument the harder it is to avoid catching in folds of the mucous membrane, or in the lacunæ of the urethra, and thus damaging it; on the other hand, the larger the instrument the more likely is it to remain in the canal and, by stretching the lining membrane, to obliterate folds and to pass by lacunæ or false passages.

So, too, in cases of rupture of the urethra, a fair-sized instrument, say No. 8 or 9, may pass over the wound and into the bladder, when

a smaller one would have its point engaged in the rent, and thus matters would be made worse than before; while in any such case, if the larger one will not pass, the smaller is unlikely so to do.

In acute inflammatory conditions of the urethra, or when the canal has been lacerated, the coudé catheter will sometimes be found of much greater value than the ordinary olivary-ended instrument.

As is well known, the meatus is in most cases the narrowest part of the canal, and it is sometimes so contracted that a full-sized instrument cannot be passed. In this case it may be carefully nicked with a scalpel, exactly in the middle line above and below, or below only, as may be required. Usually a very slight division of the tissues suffices.

Size of Normal Urethra.—In England it is generally held that a No. 12 catheter, English measure (= 20 French), represents the calibre of a full-sized urethra, or rather that if No. 10 or 12 passes easily, it may be supposed that there is no stricture. This may be taken as true for most practical purposes, but American surgeons are more liberal-minded in their ideas, both as to the size of the normal urethra, and of the instruments which may be passed along it. Otis has shown that the average calibre of the male urethra in the living is not less than 28 mm. (about No. 16 of the English catheter gauge), so that a stricture might diminish the urethral calibre 7 mm. (i.e., from No. 16 to 12) before it would be detected by what most English surgeons, and most patients, consider a full-sized instrument. Otis has further shown that normal urethras differ greatly in their calibre, and that there is a close relationship between the circumference of the penis and the tube it contains.

2. **Importance of Cleanliness.**—The surgeon should personally assure himself that the catheters he is about to use are absolutely clean ; a metal or rubber catheter should, of course, be boiled, the safest way of rendering it aseptic. To use a foul catheter is to expose the patient, wantonly, to a distinct danger of blood poisoning, and it is a question whether the duty of cleansing catheters after use should ever be left to the nurses or porters.

To Clean and Sterilize a Gum-elastic Catheter.—The instrument should be well washed in a stream of running warm water, which should flow freely through the lumen of the instrument. It should then be wiped dry on a soft clean towel, and be placed in a formalin sterilizer. These sterilizers are constructed in two forms : (*a*) A metal box, introduced by Albarran, of Paris, in which the catheters are arranged on trays. After the instruments have been placed inside the box, the open end is closed. By means of a special lamp, formalin vapour is generated and passes into the sterilizer. This vapour is powerfully bactericidal, and after contact the catheters and bougies are thoroughly sterile. Before use they should be placed in distilled water or weak boracic acid solution, as the formalin is very irritating to the urethra. (*b*) A similar result to the above is

obtainable by the use of glass tubes with a hollow rubber stopper (*Fig.* 220). Into the hollow part of the stopper trioxymethylene in powder or granules is introduced. This material slowly decomposes, giving off formalin vapour, which acts in a manner similar to the above on the catheter or bougie. The catheters are thoroughly sterilized after twenty-four hours.

Maw & Sons have introduced an apparatus for boiling gum-elastic instruments, and their special catheters will stand boiling about ten or twelve times.

With such simple methods for obtaining a satisfactory sterility of the instrument, no gum-elastic catheter or bougie should be passed which has not been subjected to some such form of treatment.

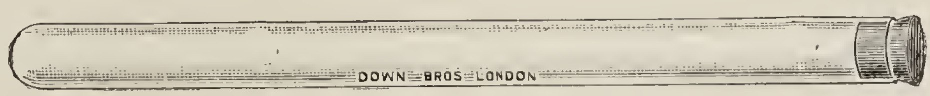


Fig. 220.—Glass Catheter Tube.

3. **Warming and Oiling.**—All instruments should be warmed and oiled before passing. A good lubricant is sterilized olive oil or vaseline, but if an antiseptic medium is desired the following may be employed :

℞	Hydrarg. Oxycyanidi	gr. iiiss	Tragacanthæ	gr. xlvj
	Glycerini	ʒvss	Aq. Dest. Steril.	ad ℥iij

4. **Constitutional Disturbance.**—The passage of any instrument, but especially if it be a metal one passed for the first time, may be followed by marked constitutional disturbance, such as a rigor, or repeated rigors, high temperature, etc. This *urethral fever*, or urethral shivering, as milder cases are called, is generally transient, but may even be fatal in damaged constitutions. Therefore Paget advised that a catheter or sound should if possible be passed for the first time, not in the surgeon's consulting-room, but in the patient's own room. A dose of quinine gr. v, opium gr. j, is an excellent prophylactic if rigors are feared.

Retention of an Instrument in the Bladder.—Under certain circumstances, either to dilate a very tight stricture (passive dilatation), or to drain an inflamed or injured bladder, to prevent extravasation of urine in the milder varieties of laceration of the urethra, or to check severe bleeding from this canal, it is necessary to retain a catheter for some considerable time.

As a general rule a gum-elastic or rubber instrument should be used, and unless there is some very strong reason to the contrary it should be changed at the end of twenty-four hours.

There are several methods for securing the instrument, but it may be laid down that no method will succeed without the co-operation of the patient. A catheter cannot be tied in so firmly that the patient, if he wishes, will fail to remove it.

For the male an excellent method is one described by Carwardine : A ring of bone or rubber (an old catheter may be used, the narrow point being introduced into the lumen of the wide part, after such

reduction in size as may be necessary, and the junction made firm by a silk suture passed through the walls of the tube) is passed over the penis and secured by tapes passing round the groins, thighs, and umbilical region (*Fig.* 221). This ring can be very firmly secured, and acts as a basis to which the catheter can be attached. The catheter is then introduced along the urethra, and is fixed to the ring by four or six silk threads. These threads are passed through the exposed end of the catheter by means of a needle, tied, and finally secured to the ring. They can be adjusted to any length, and if a certain ' play ' of the catheter is required it can be allowed for.

Other methods which may be mentioned consist in fixing the catheter directly to thigh and perineal bands, to the pubic hair—a method sometimes useful in the female—or to strips of strapping placed round the penis.

Whichever method be adopted, there are other details to be considered. The end of the catheter, when fairly introduced into the bladder, will rest against the sensitive trigone ; in many subjects this position causes great discomfort, which can be easily remedied by allowing the point of the instrument to lie in the prostatic urethra instead of in the bladder cavity. At regular intervals, every two or three hours, the catheter is pushed on into the bladder to allow that viscus to be emptied, and is then withdrawn to its original position. If the patient is intelligent he can often effect this manœuvre himself. Such a modification may be adopted in all cases unless there is a special need to keep the bladder absolutely emptied, if the patient is sensible and quiet.

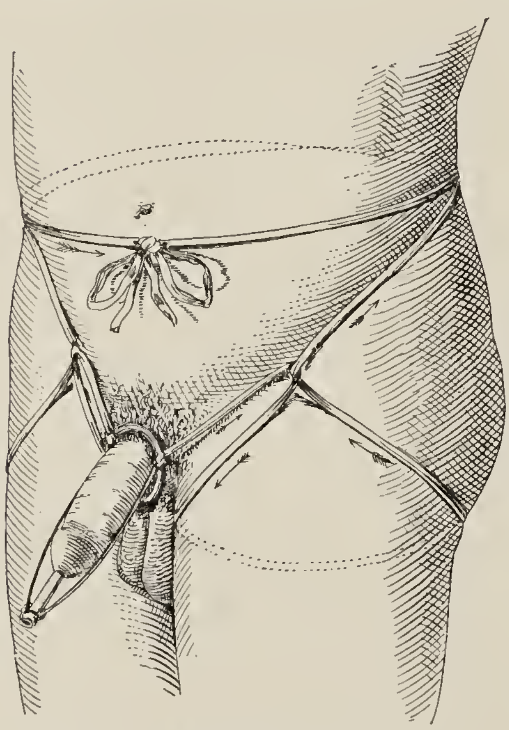


Fig. 221.—Method of tying in a Catheter.

It is often stated that rubber are better tolerated than gum-elastic catheters ; but this is not always the case, as the surface of the rubber instrument seems slightly more irritating than the polished gum-elastic surface. Gum-elastic catheters are prone to ' blister,' i.e., a curious cracking of the varnish. In some cases this is due to faulty construction, in others to some irritating quality of the urine. All blistered instruments should be at once removed.

Children do not tolerate catheters *in situ* very well, and unless absolutely essential this form of treatment should not be undertaken.

A slight urethral discharge sometimes follows the tying in of a catheter, and phosphates are often deposited at the end of a catheter which has been left *in situ* for more than twelve hours. In all cases where a catheter is tied in, the patient should be put on doses of

hexamine, gr. x, acid sodium phosphate, gr. xv, twice or three times a day; and if the urine is markedly alkaline, the bladder should be washed out with weak hydrochloric acid, 1–5000 to 1–2000.

OF THE PASSAGE OF URETHRAL INSTRUMENTS.

The Passage of Metal Catheters.—In almost all text-books which treat of the practice of surgery, a verbal description will be found of the manœuvres necessary for the introduction of a metallic catheter into the bladder, but we believe that such descriptions are only waste of space, and of the author's and reader's time. We do not think it is within the power of words to convey to a student, who has no personal experience, any real idea of the movements of the hand and wrist, or of the complex sensations which guide and inform the surgeon of the position of the point of the instrument, of the direction in which it is travelling, or of the condition of the canal which he is exploring. Such descriptions are no doubt perfectly intelligible to those who know the direction of the urethra, but these stand in no need of them.

There is only one way to learn to pass silver catheters, and that is, to pass them, at first of course under direction; and it may not be out of place to remind house surgeons and dressers that they will in all probability never again have such opportunities of practice; and although we are far from advising unnecessary catheterization, still they will do wisely to seize all legitimate occasions for acquiring that most important accomplishment, the being 'a first-rate hand with a catheter.'*

We have already said that in passing catheters the rule should be to proceed downwards size by size, until the largest which will pass is arrived at. This is especially true of metal instruments. The smallest sizes (Nos. $\frac{1}{2}$ to 3 English = 1 to 8 French) are difficult to

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* The dresser then should, from the first moment of entering upon his work, determine to learn how to catheterize, and may profitably set about it in some such way as the following. To begin with, he can conveniently learn the general direction of the urethra in children and adults, and pretty frequently even in prostatic cases, by passing full-sized instruments in the dead-house. And he will there also learn, to a certain extent, the 'feel' of the normal urethra. He should then look out for cases, which will be fairly numerous in the wards, which require the regular passage of an instrument: such cases as those of chronic cystitis, atony of the bladder, paralytic cases, and the like. Having learned the normal urethra, he should now go on to cases of chronic stricture where the urethra presents no difficulty, such as those which are on the high road to recovery, or in which the obstruction is only commencing; thence he may proceed to the more difficult ones, and to the use of the prostatic catheter, and so on till he feels that he stands on tolerably firm ground. In all those cases the house surgeon may be of the greatest assistance to the dresser in his ward and casualty work, and he may rest assured that help thus kindly and timely rendered will never be thought lightly of, nor forgotten in after years.

pass, even along urethras which are healthy, and damage is readily inflicted by them.

Catheters of a very large size are chiefly employed for the removal of débris in the operation of lithotrity ; or after perineal section ; or, as has been mentioned (p. 30), they may be required for the removal of blood clots. In passing them great care must be taken not to injure the urethra.

Silver Prostatic Catheters are longer and more boldly curved than the ordinary ones. Generally speaking, a full-sized instrument (No. 12) is very easy to pass, slipping in almost by its own weight, but the use of metal prostatic instruments of a small calibre should be avoided, except for very good reasons.

The Passage of Flexible Catheters, Bougies, etc.—The use of metal instruments is becoming every day less general, and that of flexible ones more so. The latter are less liable to produce constitutional disturbance ; damage cannot so easily be inflicted on the urethra by them ; and they require less skill for their introduction. For all general purposes, the olivary shape (*see Fig.* 217) will be found the best. Cheap catheters are always bad and unsafe to use.

The method of introduction of the ordinary black, flexible catheters and bougies, or of whalebone bougies, or catgut, calls for no remark, but with regard to the stiffer form of gum-elastic instrument, it should be mentioned that the stylet which serves to keep them in shape should in almost all cases be withdrawn before they are passed.

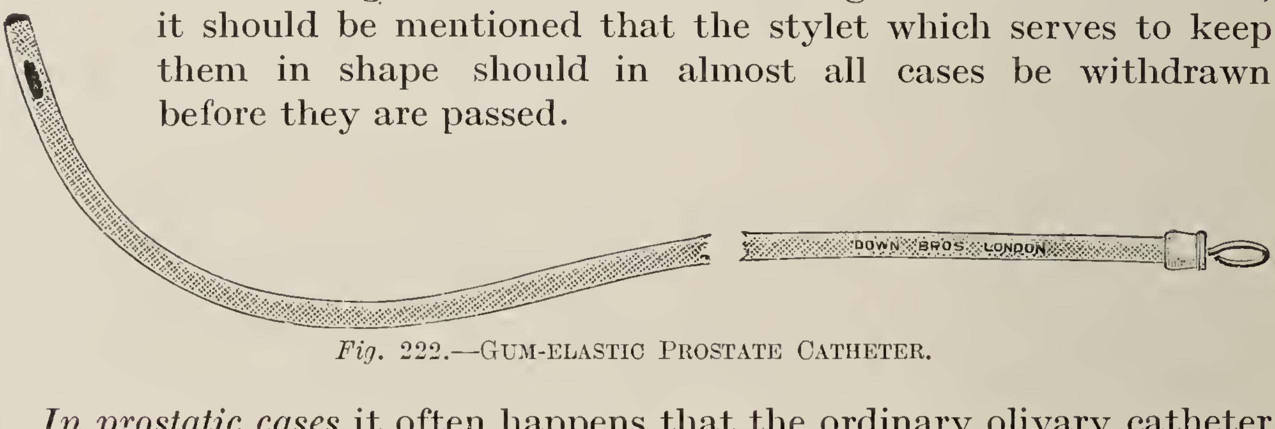


Fig. 222.—Gum-elastic Prostate Catheter.

In prostatic cases it often happens that the ordinary olivary catheter hitches against the middle lobe of the gland, and will not pass. Sometimes it will be found that a very soft india-rubber one will ride easily over the obstruction, and still more often an elbowed instrument (*coudé*) will do so. But a good deal of manœuvring may be required in such a case. Thus, the finger may be placed in the rectum, or the perineum may be supported. Another method that sometimes succeeds in difficult cases is to pass a gum-elastic catheter (*Fig.* 222) with a stylet bent to a sufficient curve, and when its passage is arrested, to withdraw the stylet for about an inch and a half. This may have the effect of raising the point of the catheter almost vertically over the lobe of the prostate, and if this occurs it will pass into the bladder upon the complete withdrawal of the stylet.

Difficulty is often experienced in passing a catheter on a patient lying in bed. This is due to the fact that the pelvis sinks into the soft mattress, and a sharp kink is found at the triangular ligament.

If the buttocks are raised on a pillow or other support the catheter will be found to pass readily.

A good plan for the general run of cases is that recommended by Thompson, namely, to keep a gum-elastic catheter for a month or so upon an *over-curved stylet* ; then, when it has to be used, the stylet is removed and the shaft of the catheter bent back to the ordinary curve. In the passage down the urethra, through the spring of the catheter the over-curve is gradually re-assumed, so that by the time the prostate is reached, the point of the instrument rides over it.

Sounding for Stone.—The house surgeon will frequently have occasion to explore the bladder for the detection of a calculus. The old-fashioned sound was curved in the same manner as a catheter, and was passed in the same way. But, more recently, an improved hollow cylindrical handle has been adopted, and a short bulbous end almost at right angles to the stem (*Fig.* 223). These sounds are not

Fig. 223.—Clutton's Sound.

so easy to introduce, but are much better fitted to explore the bladder thoroughly. Sounding should always be performed when the organ contains a fair amount of urine ; failing this, about half a pint of lukewarm boric-acid solution may be injected.

Breaking of Catheter.—Lastly, it may happen, and perhaps more often than is generally supposed, that a defective instrument breaks off short at the eye, and that the fragment remains in the urethra. This accident should not occasion undue alarm, although the result may possibly be serious. If the piece can be felt in the penile or bulbous urethra, efforts may be made to work it forwards by manipulation until it can be easily seized by a pair of urethral forceps. If it can be felt, but cannot be moved, then these forceps may be very carefully passed down to it, every precaution being taken not to push it backwards into the bladder ; but no good can come of plunging the forceps blindly into the urethra if the fragment cannot be felt. In such a case the best course is to send the patient to bed, to direct plenty of non-irritant fluids to be taken, and to diminish local spasm by means of morphia as a suppository or hypodermically, or by opiate enemata.

In all probability the missing piece will be passed in the urine within twenty-four hours, but if this should not be the case, no personal consideration on the part of the dresser or house surgeon, and no absence of symptoms on the part of the patient, should prevent an immediate report to the visiting surgeon, on whom will devolve the responsibility of deciding, firstly, whether the piece is still in the urethra, or is in the bladder, and, secondly, what further steps should be taken for its removal.

THE CYSTOSCOPE, THE URETHROSCOPE, AND THE URINE SEPARATOR.

The student should familiarize himself with all these instruments, as they are of the greatest service in investigating renal and vesical diseases. The cystoscope has come into general use, and after a short course of practice, enables one to ascertain with certainty the condition of the bladder and ureteric openings.

The Cystoscope (*Fig.* 224) is a hollow metal cylinder with a lamp and prism at one end, which is known as the beak, and a lens, usually fitted with a hood, at what is known as the eye-piece. Of the various forms of instruments, Ringleb's is in most general use. The lamp is of special manufacture, and does not become too hot when illuminated so long as there is a sufficiency of fluid in the bladder. The connection with the battery or accumulator is made at the eye-piece, and it is always better to use these means of obtaining a current

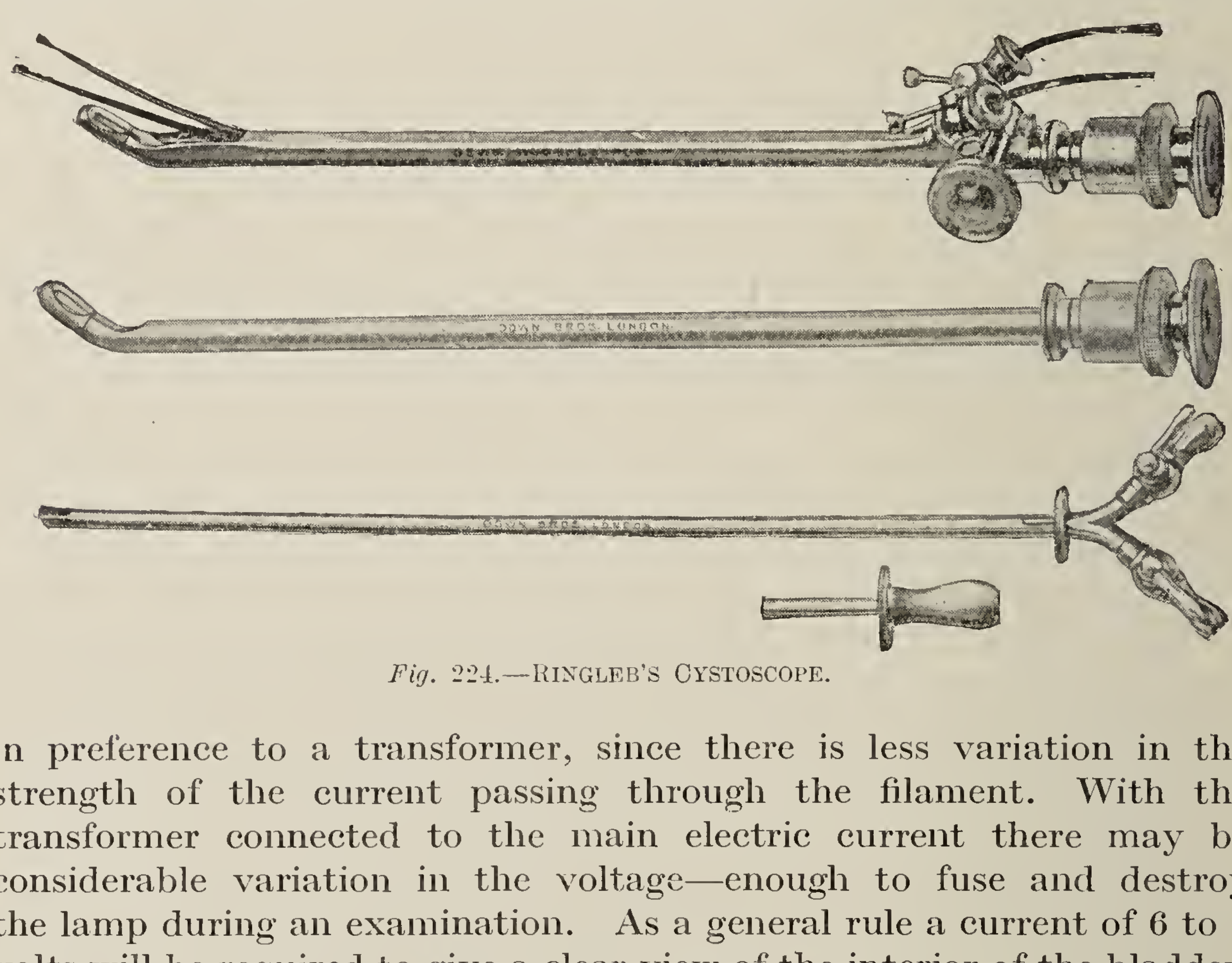


Fig. 224.—Ringleb's Cystoscope.

in preference to a transformer, since there is less variation in the strength of the current passing through the filament. With the transformer connected to the main electric current there may be considerable variation in the voltage—enough to fuse and destroy the lamp during an examination. As a general rule a current of 6 to 8 volts will be required to give a clear view of the interior of the bladder.

The usual size of the ordinary cystoscope is 19 to 21 mm. F., but smaller sizes may be obtained for use in younger patients.

To Sterilize the Cystoscope.—Some instruments are now made which can be sterilized by boiling, but the outer tube and lamp cannot be treated in this manner. In order to render it sterile it should either be immersed in a perpendicular jar filled with strong carbolic-acid solution (B.P.), the solution reaching to within an inch of the eye-piece, or the shaft and beak can be wiped over with a piece of gauze or lint soaked in this solution. The carbolic acid is then removed by

dipping the cystoscope in distilled water or saline, and wiping it with a sterile cloth. It is better not to use spirit, as this may soften the setting round the lamp and prism. Care must be taken that all the carbolic acid is washed away.

To Prepare the Patient.—Either a local or a general anæsthetic may be used. If a patient is very nervous and has a narrow urethra, it is advisable to put him under ether or chloroform, so that a thorough painless examination may be made. In most cases, however, a local anæsthetic is sufficient.

Local anæsthesia is induced by injecting 5 per cent solution of cocaine, cocaine and adrenalin (1–10,000), or β-eucaine, into the urethra. There does not seem to be any grave objection to the use of cocaine, unless there is ulceration of the canal. The technique is as follows :—

The patient lies on the operating couch, on a sheet of macintosh, a sterilized towel over the lower extremities and over the lower part of the abdomen ; the genitalia are freely exposed. The penis and the meatus are well washed with a solution of lysol 1–40. A small glass pipette holding ½ to 1 drachm, with a rubber nipple, is filled with the cocaine solution ; the penis is held by the fingers and

Fig. 225.—Bladder Syringe.

thumb of the left hand, the pointed end of the pipette is inserted into the meatus, and the fluid is induced to enter the canal by pressure on the rubber nipple. As soon as the contents of the pipette have been discharged into the urethra, the fingers and thumb of the left hand grasp the glans somewhat firmly to prevent the escape of the fluid. (If there is much spasm the solution may be almost immediately rejected, in which case another injection should be made.) If the fluid has entered the canal properly, the right hand is used to press gently and massage the fluid from the penile into the deep urethra. The left hand still retaining firm hold of the glans, the whole organ is slightly stretched, so as to pull forward the bulbar region. With a little patience it is quite easy to coax the injection into the prostatic urethra, so that when the left hand is relaxed there is no escape of the cocaine solution. If the solution escapes, the injection has not been given satisfactorily, and the deep urethra will not be anæsthetized.

The next step is to wash out the bladder with a syringe (*Fig.* 225), and the amount of washing needed will depend upon the degree of turbidity of the urine. In some cases it may be necessary to wash for half an hour, in others a single syringeful only may be required.

The cystoscope should now be introduced. Glycerin is a better lubricant than oil, as the latter makes the window dirty. Before attempting to pass it, connect it up with the battery and see that the lamp is in proper working order.

The instrument is introduced with the beak upwards, the penis being held vertical, until the point impinges against the triangular ligament ; the instrument is now gently depressed, and it will be felt to slip easily along the deep urethra into the bladder. It is better to introduce the cystoscope with the telescope in place, since the edge of the opening may catch the urethra and cause bleeding.

If there is a hitch at the triangular ligament, withdraw the cystoscope slightly, and then try again. If there is some obstruction in the prostatic urethra, depress the eye-piece gently between the patient's thighs.

There are a certain number of cases in which the cystoscope cannot be passed, and if it is found that after careful manipulation further progress into the bladder is arrested, the attempt should not continue. Possibly a prolonged effort might meet with success, but it will cause bleeding, and not only is this alarming to the patient, but it generally prevents the operator from getting a clear view of the interior. It is far better to accept defeat and make a fresh attempt later.

Having introduced the instrument successfully, place a block or large book (6 inches deep) under the patient's buttocks ; such a step facilitates the examination considerably.

Next wash out the bladder with weak boracic acid or normal saline (either large syringes or an irrigator may be used) until the fluid that returns is *quite* clear. To test for clearness, let some of the returning fluid escape into a small medicine glass, hold this up to the light, and see if it is quite transparent. If there be much bleeding from a growth or an inflamed bladder, wash out with $AgNO_3$, 1–1000, or introduce 4 to 6 drachms of adrenalin solution, 1–10,000. A certain quantity of lotion, 8–10 oz. or less according to the capacity of the bladder, must be left.

Replace the telescope, which was withdrawn for the washing, and then connect the cystoscope up with the battery and examine the interior of the bladder. With the beak in the position in which it was introduced, the fundus and anterior wall will be under observation. To examine the base, rotate the whole instrument, noting the position of the beak by means of the small indicating knob on the eye-piece. When the beak looks directly downwards, the region of the trigone will be under observation. To find the ureteric openings, turn the beak of the instrument to the right or left. If we can compare the rotation of the instrument to the movements of the hands of a clock—the indicating knob corresponding to the minute hand—when this point lies in the position of the minute hand at twenty minutes past the hour, the left ureteric opening will be seen ; when at twenty minutes to the hour the right will be visible. These

openings lie usually at the extremities of a prominent bar, Mercier's bar, and the localization of this bar will assist the student in finding them. In examining the bladder with the cystoscope it must be remembered that the image seen is upside down, and of two objects the one nearer to the observer appears the further off.

The details of the various pathological conditions that may be met with are beyond the scope of this work.

The Urethroscope is an instrument for examining the urethra by means of a strong light projected along a metal tube which has been introduced into the canal. It is exceedingly valuable in detecting the cause of a persistent gleet, and in locating the position of a stricture. Although it is possible to pass the inspection tube beyond the triangular ligament, this step is rarely required, and indeed the examination of the deep urethra is much less satisfactory.

Pardoe's instrument (*Fig.* 226) is the best for general purposes. It consists of a series of tubes of different sizes to suit the calibre of the urethra to be examined, which can be fitted on to an eye-piece containing a lamp and prism by means of which the tube is illuminated. There is also an arrangement for inflating the urethra after the apparatus is in position, which enables the observer to distend the canal, and so obliterate any folds of mucous membrane which would interfere with a good view of the part. The tubes are mounted on blunt-ended pilots to facilitate their introduction.

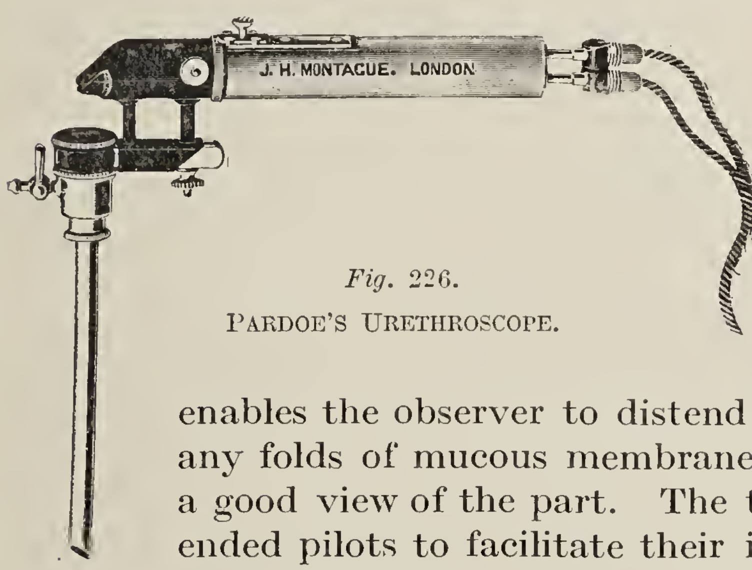


Fig. 226.
PARDOE'S URETHROSCOPE.

To prepare the patient, follow the directions given under 'Cystoscope.' Unless he is very nervous, cocaine is not required, and when employed it should only be injected into the anterior part of the canal.

Now pass the largest-sized tube that the urethra will take without causing discomfort, as far as it will go along the canal. If there is no obstruction the pilot should reach the triangular ligament. When the instrument has been passed as far as it will go, withdraw the pilot and get the patient to hold the penis steady ; some care must be exercised at this point, otherwise the sharp end of the tube may easily inflict some damage on the urethral mucous membrane, especially when inflamed. Gently mop out the tube so as to remove any moisture that is present. The best way of doing this is by means of long wooden spills, about the thickness of ordinary wooden matches, around the end of which a small pledget of cotton wool is twisted. These mops can be made very quickly and cheaply, and after use they can be thrown away or burnt. If these are not at hand a long probe will serve as a substitute, but this involves the repeated changing of the

cotton-wool. In any case the canal must be thoroughly dried before any satisfactory view can be obtained. If the pledget of wool comes off the spill or probe, and remains in the urethra, it can easily be removed by means of urethral forceps introduced along the tube, and need cause no anxiety.

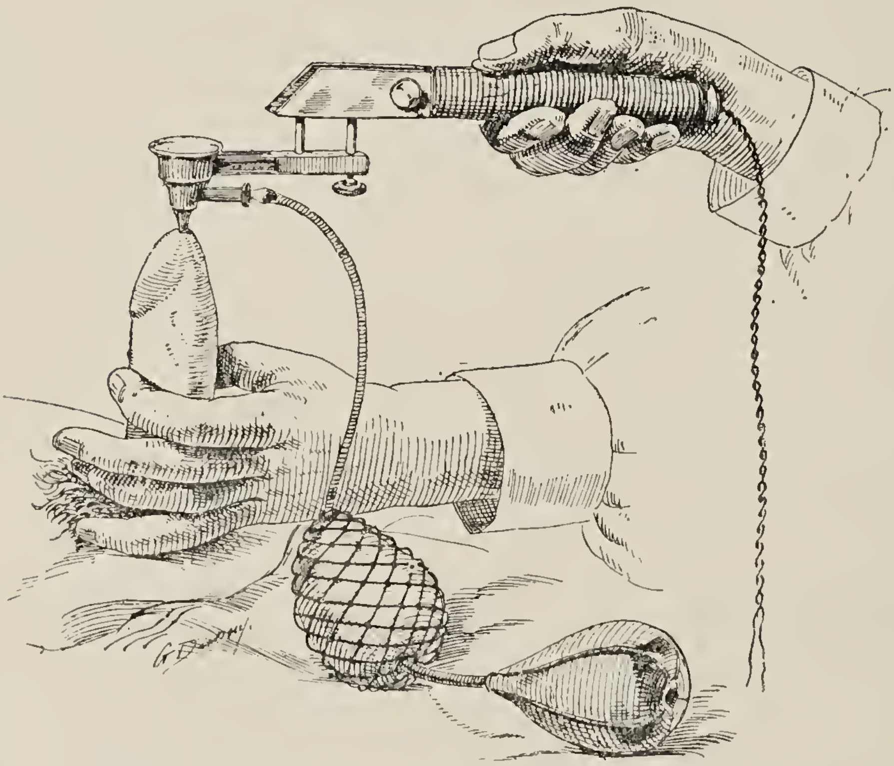


Fig. 227.—Method of using the Urethroscope.

Now connect the handle of the urethroscope to the battery and accumulator and see that it is working satisfactorily, and then fit the eye-piece on to the end of the tube which is in the urethra. Grasp the penis with the left hand so as to steady the tube, while the handle of the urethroscope is held by the right (*Fig.* 227); switch on the light and examine the illuminated field.

Get the patient to squeeze the rubber ball of the inflating apparatus, and when the reservoir is full of air, turn the small tap, which places the air-tube in communication with the urethra. The air rushes in and distends the canal, making any stricture that is present very obvious indeed. The stricture appears as a small black or dark red point in the centre of a pale pink area; a very little experience will enable the observer to recognize the various forms and the different degrees of stricture, as well as to distinguish them from false passages. If no stricture be present, gradually withdraw the tube, which is still connected to the eye-piece, examining the walls of the canal for patches of granulations or inflamed follicles; the whole canal must be carefully and systematically examined, fresh inflation being practised if necessary, and in this manner some valuable information as to the state of the urethral tract may be obtained.

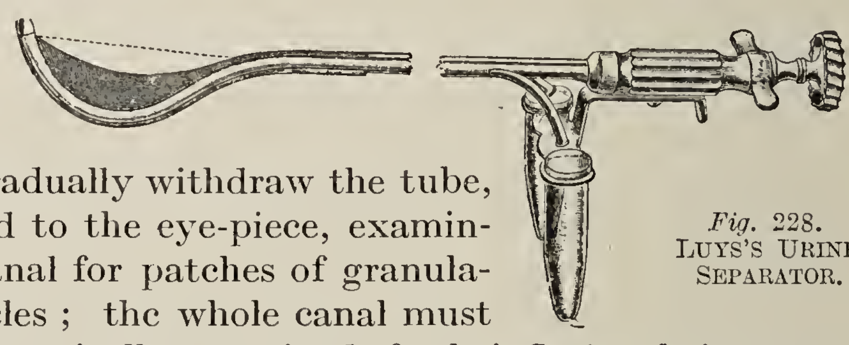


Fig. 228.
Luys's Urine Separator.

The Urine Separator, an instrument designed by Luys (*Fig.* 228), was formerly used for the purpose of collecting the urine separately as it descended from each ureter. The same result may be obtained by means of the ureteric catheter passed along a special form of cystoscope, and this catheter has now superseded the earlier instrument.

CHAPTER XXXVII

ASPIRATION AND TAPPING OF THE BLADDER. RETENTION AND SUPPRESSION OF URINE, ETC.

ASPIRATION of the Bladder above the Pubes.—This has become the common way of emptying the bladder by other than the natural passage, when an attempt to pass a catheter has failed.

The instrument used may be the one previously mentioned (*see* under 'Abscesses,' p. 273), or an ordinary fine trocar and cannula. In any case the operation is of the simplest ; the points to bear in mind are : (1) That the condition of the bladder must be accurately made out, and the thickness of its walls estimated as far as possible, for a bladder may be over-distended, and yet, through the muscular hypertrophy of its walls, may rise only a very little way over the pubic crest ; (2) That the aspirating trocar must be very sharp, so that the bladder walls, if thus thickened, may be readily pierced ; (3) That the bladder must be entered fairly at right angles, just above the pubes ; (4) That the bladder must form a definite tumour—it is not sufficient to rely on dullness alone ; (5) That care must be taken not to mistake distention of the organ with blood for distention with urine. A fine trocar and cannula (*Fig.* 229), not a pen-pointed hollow needle, must be used, and the best pattern is that in which the trocar acts as a piston, and, when withdrawn through the cannula, allows the urine to escape by a side branch. The patient must be lying down while the aspiration is being performed, and the operation done with all antiseptic precautions. The depth at which the bladder is reached depends upon the amount of fat present, and upon the thickness of the bladder. The length of the trocar and cannula should be at least 4 inches.

Washing out the Bladder.—This treatment is often required in cases of cystitis, whatever be the cause of the condition, and although the operation is easy enough, it requires some care to avoid giving needless pain or harmful irritation. The fluid used should always be warmed to about 98° or 100°, and should contain some antiseptic, such as perchloride of mercury (1–4000), carbolic acid (1–500), sulphate of quinine (2 to 4 gr. to the ounce), boric acid (saturated solution), acetate of lead ($\frac{1}{4}$ gr. to the ounce), or nitrate of silver ($\frac{1}{4}$ gr. to the ounce).

Before proceeding to wash out the bladder, it should always be emptied by drawing off the urine with a soft catheter. The amount injected must vary with the capacity of the bladder, but not more

than two or three ounces should be injected unless a double-channelled catheter is used or the capacity of the bladder is known.

A Two-wayed Catheter (*Fig.* 230) is often used for this purpose, and does well, although no better than other simpler plans. The instrument, which is made in silver or gum-elastic, and which contains, as shown in the figure, two channels, with separate apertures, is inserted in the ordinary fashion ; the catheter end A is connected to the tube of a small irrigator, or the fluid is introduced by means of a glass or metal syringe.

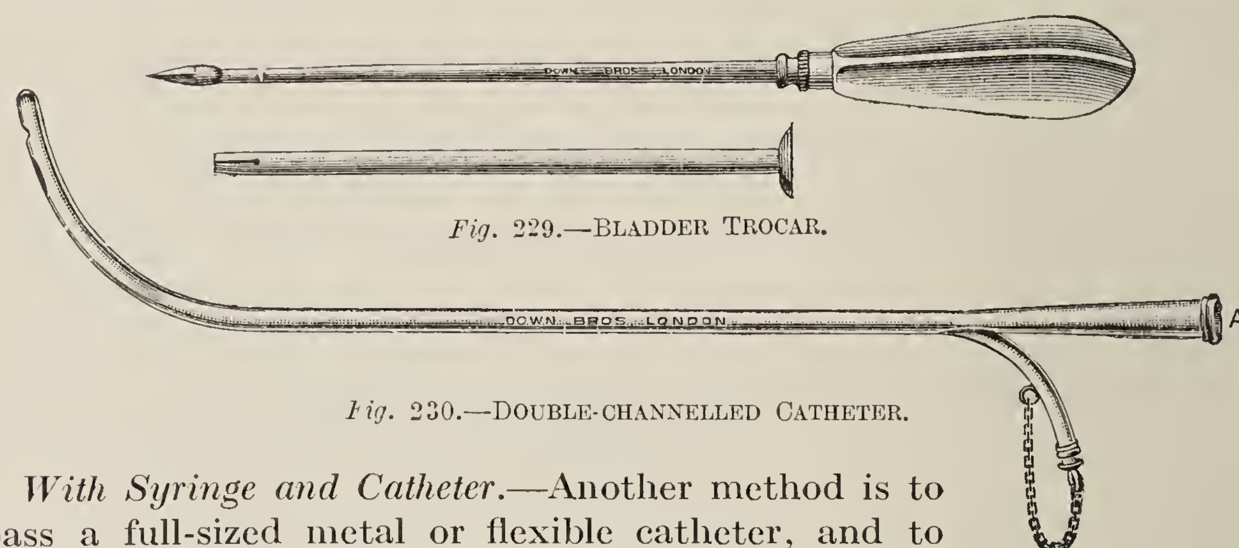


Fig. 229.—BLADDER TROCAR.

Fig. 230.—DOUBLE-CHANNELLED CATHETER.

With Syringe and Catheter.—Another method is to pass a full-sized metal or flexible catheter, and to inject as before, but limiting the amount to well within the capacity of the bladder ; when the syringe is disconnected the bladder will eject the fluid, and the washing may be repeated.

With Tube, Funnel, and Catheter.—All the advantages of the two-wayed catheter, without its complications, may be secured by passing a large catheter and attaching to it a tube with a funnel at one end. The tube should be not less than 3 ft. long, and the funnel should first be held about a foot above the level of the bladder, and a sufficient quantity of fluid poured into it until the bladder is filled ; this being done, the funnel should be depressed below the bladder level ; both funnel and tube will now act as parts of a syphon, and the fluid will be drawn off from the cavity of the bladder. The greatest care must be taken that air does not enter the organ, and no washing out should be done when acute cystitis is present. Distention of the bladder when acutely inflamed is exceedingly painful, and it is better merely to introduce 1 to 2 oz. of some sedative solution—boroglyceride 1–20—and allow it to be expelled naturally.

This method we believe to be the simplest and the best, but in it, as in all others, care must be taken not to distend the bladder walls, and also not to inject any air into the bladder cavity. The suffering which the presence of air there causes, and the difficulty with which it is expelled, are somewhat remarkable when both the tolerance and the power of expulsion of gas shown by the neighbouring viscus, the rectum, are considered.

To Wash out the Urethra.—The urethra itself has to be washed

out in the treatment of gonorrhœa, and also very rarely in other affections of that canal. The injection of warm lotion is generally done by the patient himself, with a glass syringe holding two or three ounces : a single syringeful being thrown up, retained for a couple of minutes, and then ejected.

This method does well enough for affections of the spongy or membranous urethra, but may not effectually wash out the prostatic portion. When this is required to be done, a good plan is to pass a short silver catheter, e.g., a female one, to just beyond the compressor urethræ muscle ; then to inject 10 oz. of a mild astringent lotion into the bladder, and afterwards to allow it to be slowly and naturally expelled, so that the prostatic urethra is twice washed over.

(*See also* ‘Gonorrhœa,’ p. 310).

RETENTION OF URINE.

In any large general hospital it is a matter of daily experience that cases of disease or injury present themselves in which the condition demands that immediate action must be taken ; and it will sometimes happen that it is not possible for the resident medical officer to obtain the attendance of one of the visiting staff quickly enough to be of any use.

It is quite impossible to draw any line within which he may feel free to exercise his own responsibility, for the rules at different hospitals vary, and much will depend upon the length of service and personal experience of the particular officer ; for example, in a case of retention of urine, with a practically impassable stricture, a house surgeon recently appointed should not proceed beyond a fair attempt at catheterization before he sends for help, while another who has served a year or more might be justified in going on to aspiration of the bladder.

Still, to the following rule there can be no exception : *In all cases of doubt the house surgeon must send for the visiting surgeon at once*, and if the case be urgent he can but do his best in the meantime, adopting curative or temporizing measures, whichever seem to him to be right.

We shall discuss some measures which border upon major surgery, such, for example, as deep perineal incisions, chiefly because they are the logical sequence of the failure of less severe proceedings, and in order that the junior surgeon should not feel as if with these failures the end of all resources had been arrived at, although the operative steps themselves are most frequently undertaken upon the advice and under the direction of his senior.

Cases of obstruction to the flow of urine, ‘*retention cases*’ as they are termed, form a class which probably give house surgeons more anxiety than any other, and certainly no subdivision of surgical practice can show a worse record of damage done through careless or ignorant treatment.

Causes of Retention.

The causes of retention of urine may be grouped as follows :—

Phimosis, as a cause of acute retention, is usually met with in infants, and is frequently associated with an extreme degree of contraction of the meatus. The symptoms produced are those of bladder irritability, and vesical calculus is often suspected. Further, the hypertrophied muscular fasciculi of the bladder will often give a peculiar sensation when a sound is introduced, which may be mistaken for a stone.

In later years phimosis, even if untreated, rarely leads to retention ; but if to the original contracted state of the opening there be added the effects of inflammation and ulceration, and possibly of preputial calculi, retention will occur.

The Impaction of a Calculus in the Urethra is a second cause, more frequent in those of tender years, but not confined to them.

The Introduction of a Foreign Body, or *the ligation of the penis by a string*, are other conditions which occasionally demand recognition. These are also most frequent in young patients, but occur in those of riper years. A string is occasionally tied round the penis of a child who suffers from nocturnal incontinence.

Gonorrhœa may lead to retention of urine from three distinct causes : (1) Congestion of the swollen mucous membrane, and spasm of the compressor urethræ muscle—the so-called spasmodic stricture. This is of rare occurrence, though we shall have occasion to refer to spasm as a cause of retention later on. (2) Acute prostatitis. This follows an extension of the infective process, and is a more frequent occurrence than that just mentioned. (3) A peri-urethral abscess. This, developing in the course of an acute urethritis, leads to the formation of a quantity of pus, either in the superficial or deep perineal pouch. Such a collection, being as it were encapsulated and restrained by the fascial envelopes of the perineum, presses back against the urethra and prevents the flow of urine.

Stricture.—The fibrous narrowing of the canal secondary to injury or gonorrhœa leads, if untreated, to retention of two types :—

In the first there is a gradual narrowing of the lumen of the urethra, contraction of the bladder, and frequency of micturition. Ultimately a final stage is reached, when the bladder becomes distended and powerless to expel its contents properly. In many of these cases there may be no obvious tumour in the hypogastric region, such as is supposed to be associated with a true retention. This is due to the fact that the capacity of the bladder is so reduced that even when filled to its extreme limits it does not rise much above the pubes.

This type of retention is the most insidious and dangerous. The term retention with overflow, or false incontinence, has often been given to it, but it would be better to confine this term to those cases where the bladder is obviously distended, as in enlargement of the prostate, and to apply the term *latent retention* to the form just described.

In this form the patient comes up for treatment stinking of urine, which, constantly escaping from the urethra, undergoes decomposition on the clothing. Such cases may be mistaken for incontinence, and be treated with belladonna in the hope of diminishing the irritability of the bladder. Not only is the stricture exceedingly tight in such cases, but the general state of the patient is infinitely worse than in the form which we shall next discuss. As the result of obstruction extending over a number of years, the kidneys are grossly damaged, and a fatal termination unfortunately often follows even the gentlest methods of treatment. Because such a patient can pass some water, the urgency of his condition is often overlooked; whereas, by comparison with other cases of acute retention, although perhaps the patient suffers less, the condition and outlook are far more serious.

The second form of retention is one of sudden and absolute retention occurring in a patient who is suffering from stricture, and often in one who is under treatment for the same. After a bout of alcoholic excess, a sudden chill, or prolonged pressure on the perineum, retention suddenly sets in. The bladder distends, the sufferings of the patient increase, but timely treatment promptly brings complete relief. It is not quite clear how these three factors—alcohol, chill, and perineal pressure—lead to the same condition of retention. Alcohol probably causes a weakness or temporary paralysis of the already overstrained muscular mechanism of the bladder ; while a chill, and possibly also pressure on the perineum, lead to congestion of the narrowed urethra, or spasm of the constrictor muscle. In some instances retention has followed a long bicycle ride.

An Enlarged Prostate, whether inflammatory or neoplastic, is a common cause of retention of urine. Acute inflammatory conditions have been previously mentioned. Chronic parenchymatous prostatitis only rarely leads to this state. In the senile forms of enlargement, both in the simple adenomatous variety and in the carcinomatous mass, retention may occur. In some cases this complication sets in quite suddenly ; sometimes it is the first and only symptom of prostatic enlargement that is noticed. In others the onset is more gradual, a progressive accumulation of residual urine leading in time to an atonic distended bladder, with a constantly recurring dribbling from the urethra—that is, to retention with overflow. This retention with overflow is not always productive either of pain or inconvenience. Some patients are seen with a bladder distended up to the umbilicus who appear quite comfortable and who resent the suggestion of a catheter or other operative procedure. Nor, again, does the urine always merely dribble away. The patient may micturate at definite intervals, passing several ounces at a time, without appreciable diminution of the vesical swelling. Sudden retention in prostatic enlargement appears dependent upon factors similar to those concerned in retention from stricture, namely, alcohol, cold, inflammation, drugs. Alcohol and chill will act as before described. Inflammation may

complicate an adenomatous growth, especially if calculi are present, and may lead to retention and prostatic abscess. Drugs sometimes prescribed for vesical irritation—for example, belladonna and more rarely morphine—may produce retention. They should never be given without the closest observation in cases of enlarged prostate, or indeed in any case where there is known to be obstruction to the outflow of the urine.

Severe Hæmorrhage into the Bladder will cause retention from the coagulation of blood on the bladder base. The condition is not very common. The four main causes of profuse hæmorrhage are: (1) Clots descending from the kidneys, after injury, in new growth, and more rarely in tubercle of these organs; (2) Hæmorrhage from ruptured varicose veins on the bladder base, the retention which follows free hæmaturia being the first and only symptom of the trouble; (3) Hæmorrhage from a growth of the bladder, usually a villous tumour; (4) Hæmorrhage from prostatic enlargement, either spontaneous, or after the passage of instruments; (5) Acute cystitis, especially that form produced by the *B. coli.*

Retention following Injuries to the Perineum and Urethra.—It often happens that retention occurs as a sequel to a trauma which produces either a rupture, a laceration, or a bruising of the urethra. In all cases such a condition of retention is purely protective, since the flooding of bruised or lacerated parts with urine, apart from the intense pain that it will cause, necessarily increases the risk of extravasation and peri-urethral suppuration. In all cases of urethral damage, the patient should not be permitted to pass his water naturally until some means have been taken, as quickly as possible, to deal with the condition.

Spasm.—Simple spasm, without any organic lesion of the urethra, may produce retention. How far such a condition is associated with some as yet undemonstrated lesion of the nervous system it is difficult to say. There is probably a close relation between retention due to simple spasm and hysterical retention. We meet with many degrees, from the stammering bladder described by Paget, where the patient cannot micturate in a public urinal, a condition obviously due to imperfect nervous control, up to cases where retention is absolute and complete.

Injuries and Diseases of the Nervous System.—The commonest interference with the act of micturition following injuries of the spinal cord is retention. This may be said to occur at first in all cases of extensive damage of the cord, or even of the cauda equina. Later, it may give way to reflex or to true incontinence. Urinary troubles are certainly variable both in injuries and diseases of the nervous system, and this is no doubt due to the complex nature of the nervous mechanism which controls the bladder.

In head injuries with compression of the brain, retention usually results, while of the more chronic diseases which produce this symptom,

tabes and bilateral lesions of the pyramidal tracts are the most important. The special clinical importance of these latter cases is that the nerve lesion is sometimes overlooked in the attention paid to the retention. It is advisable always, when possible, to diagnose a stricture with the urethroscope rather than with a sound. In some cases the urethra is lax in front of the triangular ligament ; if a small instrument, especially a small gum-elastic catheter, be introduced, there is a chance of its being caught against this obstruction, and a diagnosis of stricture may be made, the real condition of tabes being overlooked.

Post-operative Retention.—This is a temporary condition following operations, especially on the pelvic organs, and will be considered later.

One form of post-operative retention must be specially considered, now that prostatectomy is more frequently performed, namely, retention some weeks after the operation from the formation of a phosphatic stone in the prostatic pouch.

Females are more free from the above urinary troubles than are males, for anatomical reasons. On the other hand, retention from incarceration of the gravid uterus is a condition which we may be at any time called upon to treat.

Treatment of Retention.

It will be advisable first of all to enumerate the various measures we have at our disposal, and then to consider which particular remedy should be applied in an individual case. The following have to be considered, namely : (1) Removal of foreign body, stone, or ligature, incision of abscess ; (2) The introduction of a catheter, as a temporary measure ; (3) Tying in a catheter, so as to drain the bladder, or passively dilate a stricture ; (4) Suprapubic puncture of the bladder ; (5) External urethrotomy ; (6) Suprapubic cystotomy.

Domestic remedies, such as a hot bath, an enema, a sponge wrung out of hot water and placed on the hypogastrium, are measures easy of application, which should always be employed in the more simple cases of retention, such as the post-operative form, before recourse to surgical procedures. A hot bath (102° to 104°) is of great value when much spasm is present, and the patient should be kept in it until the muscles become relaxed.

Phimosis with Retention.—In this condition it may be impossible to pass a catheter owing to the contracted condition of the prepuce. Under these circumstances the swollen prepuce should be dilated with dressing forceps. If this fails, the prepuce must be slit up along the dorsum, and the meatus enlarged so that a catheter of a size consistent with the patient's age can be introduced. Unless there be any special reason to the contrary, such as active venereal inflammation, it is well, now that the patient is under an anæsthetic, to circumcise him and also to perform a meatotomy. This little operation is best performed by incising the meatus downwards and passing a fine catgut

stitch through the cut edges on either side, so as to drag up the urethral lining to the margins of the meatus. (*See* p. 416.)

Calculus or Foreign Body Impacted in the Urethra.—Here the treatment will differ according to the nature and position of the obstruction. A *calculus,* when diagnosed in the anterior part of the penile urethra, can usually be extracted with the special urethral forceps designed by Sir Henry Thompson (*Figs.* 231, 232), but it will be necessary freely to enlarge the meatus before the stone can be grasped. If impacted farther back—in the region of the triangular ligament—either of the two following forms of treatment may be adopted : (1) An external urethrotomy is performed and the stone extracted ; (2) The stone is pushed back into the bladder and crushed or removed by other methods. Unless the stone lies near the bladder in the prostatic urethra and immediately yields to the pressure of the catheter, it is better not to adopt this latter form of treatment ; since, while it is true that the immediate retention can be relieved, the further treatment of stone in the bladder of a young child is not always a matter of entire simplicity. On the other hand, provided the stone has come well down into the perineum, and incision can be made directly over it, it can be extracted with a minimal amount of damage, and the cut edges of the urethra can be accurately approximated with catgut sutures : the external wound should be allowed to heal by granulation.

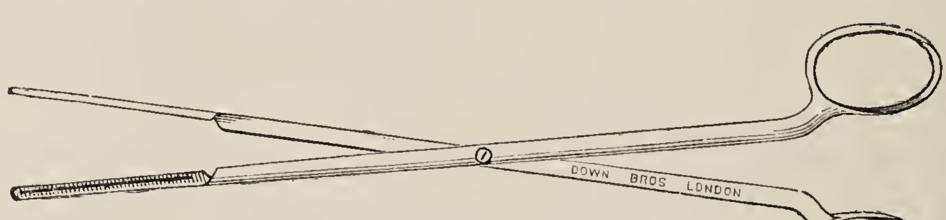


Fig. 231.—Thompson's Urethral Forceps.

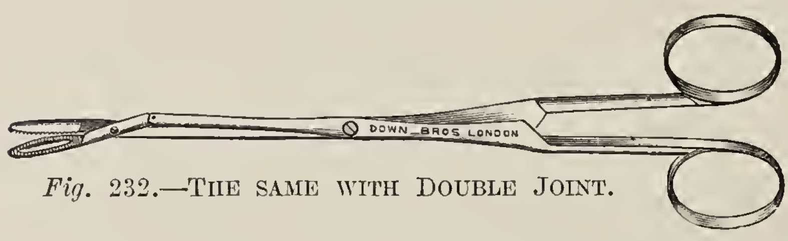


Fig. 232.—The same with Double Joint.

The wound heals quickly and kindly in about ten days, and there is hardly any leakage of urine. It is better not to tie in a catheter in young children. There can be no risk of stricture in a linear incision accurately closed. On the other hand, if an attempt be made to force a stone back into the bladder the urethra may be badly lacerated. There is one precaution, however, that should be taken in these cases, and that is to sound the bladder after the stone has been extracted, whether by the meatus or by external urethrotomy, since a second stone is sometimes present.

Foreign bodies of irregular shape, and therefore likely to produce extensive laceration, are best dealt with by perineal incision if they cannot be extracted via the meatus. It is never advisable to push a foreign body back into the bladder. In calculus the condition of affairs is quite different : the obstructing agent has come from the bladder ; ergo, it ought fairly readily to go back there. Once in the bladder it

may occasionally be dealt with by crushing, so that an open operation is avoided. On the other hand, a foreign body has been introduced from the outside, and is usually arrested in front of the triangular ligament ; to attempt to push it into the bladder is to drive it through a narrow and least dilatable portion of the urethra.

Retention in Gonorrhœa.—Here, again, the form of treatment will depend upon the cause of the retention. When acute prostatitis is present, as shown by a fullness and tenderness of the prostate on rectal examination, a trial may be made of a suppository of morphine and belladonna extract, half a grain of each, followed in one hour by a hot enema. If this fails, or if the distention of the bladder is extreme, the urethra should be washed out with permanganate of potash solution or oxycyanide of mercury 1–5000, and a catheter should be passed. A well-oiled *coudé* gum-elastic instrument, or a blunt round-end catheter, is to be preferred.

When the retention is due to spasm or congestion of the canal, similar treatment may be tried, and again recourse had to the *coudé* catheter. For many reasons this instrument is the best. It is true the rubber Jacques catheter can be thoroughly sterilized by boiling, but it does not glide so smoothly along the canal as the gum-elastic form, and anything like hesitation or delay in introducing the instrument is to be deprecated, as it causes great suffering. Ordinary oval-ended catheters are to be avoided, as in these acute inflammatory states they are more likely to catch in the urethral folds and produce tears or false passages, for it must be remembered that the mucous membrane is engorged, swollen, and softened.

A fair-sized instrument, 10 to 12 English, will be more serviceable than a small one. There seems to be some idea that a small instrument causes less pain than a large one. This is not the case, so long as a moderate size only is employed. Again, a small instrument is much more likely to catch in the urethral folds. As to the risk of the production of cystitis by carrying the organisms of contagion into the bladder, there does not appear to be much truth in it, especially if the urethra be washed out as a preliminary. Theoretically, it seems wrong to pass a catheter along a canal teeming with micro-organisms into a sensitive cavity like the bladder ; but, practically, we may do it without hesitation and without any bad effects. So long as there has been no gross damage to the organ, and the patient is kept quiet in bed, any microbes which happen to have entered the viscus are either swept away in the stream of urine or are inert, and it is consoling to reflect that the mere introduction of micro-organisms into a healthy bladder is not in itself sufficient to cause cystitis. There is always an alternative, suprapubic puncture, to relieve the acute state of retention until the suppositories and the enemata have had time to lessen the congestion.

If a peri-urethral abscess is present, a median incision and evacuation of the pus is all that is required. The urethra should not be damaged

—of this the greatest care should be taken—and the cavity of the abscess should not be tightly plugged.

Stricture.—When retention is caused by a stricture, the line of treatment must depend upon several points : (1) Whether the patient is a catheter subject, in which case a careful attempt with a catheter will invariably be rewarded by success. (2) Whether there has been any previous attempt to pass an instrument ; if so, did much bleeding accompany the attempt ? (3) Are we dealing with one of the cases of latent retention, or is the bladder obviously distended ?

Now, these cases of latent retention are the most serious. There is no great distention of the viscus, and in most instances the kidneys are extensively damaged. Some of these patients are intolerant of instrumentation ; the urethra is sensitive and rotten, and on several occasions extravasation has occurred after recourse to the catheter. Again, cystitis is usually present. In such cases suprapubic puncture should never be tried. Two courses are open to us : (1) To perform an external urethrotomy at once ; (2) To pass a catheter—this is a difficult procedure, and a very small size (No. 1 or 2) will alone be admitted—and to tie it in.

Sometimes a bougie will pass better than a catheter, and a trial may be made of tying in this instrument, as it passively dilates the urethra and allows the urine to escape alongside it.

If no instrument can be introduced, preparations should be made for performing external urethrotomy.

Stricture with Spasm.—If the case is seen before any attempt has been made to pass an instrument, trial should be made of the gum-elastic catheters and bougies With a little patience success is the rule, as although there may be a fairly tight stricture, the spasm which is also present is the chief agent producing the retention. In cases where instrumentation has been previously tried without success, it is usually no use to waste time with soft instruments. While gum-elastic catheters are admirable for the 'virgin' urethra, they are very unsatisfactory when false passages are present ; there is so much difficulty in controlling the point that they should be abandoned for the metal instrument. With the forefinger of the left hand in the rectum, the metal instrument is of the greatest value.

Different opinions are held as to the amount that should be done with a view to dilate the stricture. This must depend on the individual case. If it is found that the narrowing is long, tortuous, and extremely resistant, we may rest content with the introduction of a small gum-elastic catheter, which should be tied in. If, on the other hand, the stricture appears to yield readily, and the condition to be due to associated spasm, there can be no harm in careful dilatation up to 7 or 8 English.

The injection of a 5 per cent solution of cocaine, followed by warm oil, facilitates the passage of instruments along the urethra.

Suprapubic puncture is generally advised in those cases where

instrumentation fails, and where it is not considered wise to administer an anæsthetic. The operation is a simple one, can be performed aseptically, affords immediate relief, and can be repeated.

Certainly there are risks. The bladder has been ruptured, and fatal cellulitis, due to the escape of stinking urine, has supervened, but with care such accidents can be avoided. If a very fine trocar and cannula is employed, if the point is sharp—an important detail—and if the bladder can be *felt* as a definite hypogastric tumour, the danger of the operation is slight. It is not sufficient to rely on percussion dullness alone before introducing the trocar. If a patient is stout, a fat-loaded omentum may cause dullness above the pubes, and although in some cases retention is present, the bladder does not reach up into the abdomen. When it is known that cystitis is present, suprapubic aspiration is contra-indicated, and external urethrotomy should be performed.

Briefly, then, in the treatment of a stricture-retention, if the case is clearly one of long standing, with damaged kidneys and cystitis, external urethrotomy should be performed. In other cases, gentle trials with various sizes of gum-elastic sounds and catheters under cocaine first ; this failing, a second attempt under general anæsthesia. If false passages are present, abandon soft instruments for metal ones. If catheters are used, and a small size can be introduced, tie it in, and later the stricture can be dilated or cut. If instruments fail, perform external urethrotomy or suprapubic puncture.

Retention due to Enlargement of the Prostate can as a rule be relieved by catheter. Usually the *coudé* or *bicoudé* instrument will pass easily ; but when one lobe of the gland is chiefly affected, and when the urethra is displaced laterally, a rubber catheter armed with a stilette or stiffened with a fine gum-elastic core succeeds better. Should instrumentation fail, the bladder may be punctured above the pubes. If the patient appears to be suffering from the retention of a large quantity of residual urine—'retention with overflow'—considerable risk attends the withdrawal of the whole amount of retained urine. In some cases severe hæmorrhage from the kidneys is said to have occurred ; in others suppression has supervened. If there appears to be a larger quantity than 10 to 12 ounces, it is better not to withdraw the entire amount, but to repeat the catheterization in a a few hours' time ; or if the urine is offensive, to withdraw the whole amount and inject 6 to 10 ounces of warm boracic solution into the bladder and leave it there.

Retention caused by Retained Blood-clot.—In this case the first thing is to make a diagnosis of the source of the hæmorrhage : whether the blood comes from kidney, bladder, or prostate. In the case of the prostate, a rectal examination will usually afford sufficient information. When the blood comes from the kidney, there will be a history of injury to the loin, of previous bleeding, or of the passage of clots, and possibly a renal tumour may be palpated. When the bladder is

the source, if a papilloma or malignant growth be the cause, a history of previous hæmorrhages can almost always be obtained; whereas profuse hæmorrhage from a ruptured vein comes on without any previous warning.

Warning.—If a patient has a very large prostate causing retention, a catheter may enter a false passage in the deep part of the gland, or reach what is described by Freyer as a preprostatic pouch, a kind of loculus in the urethra ; and when the catheter is withdrawn with the eye choked with clot, it may be thought that the whole viscus is full of blood. The character of the blood in the eye of the catheter will help to make matters clear. If from a recent injury to the gland, it will be bright red ; if from a coagulum on the bladder base, it will be black.

Having settled that the case is one of retention from clot in the bladder, the treatment will vary according to the degree of distention of the viscus and the cause. If there is reason to believe that the hæmorrhage is coming from the kidney or bladder, a suprapubic cystotomy should be performed, the clot removed, and the renal or vesical lesion receive appropriate treatment. If the hæmorrhage is coming from the prostate and is not severe, it is well to follow the advice of Mr. Christopher Heath, and to introduce a suppository of morphine and belladonna extract ($\frac{1}{2}$ gr. each) and wait. Urine has a solvent action upon blood-clot, and if the retention is not urgent, this treatment is often followed by the free passage of urine and blood. It must be clearly understood that there is no urgency.

But if the bladder is fully distended, it may be advisable to introduce a gum-elastic catheter and to twist it round in the bladder to break up the clot ; then, after withdrawing it, to insert the tube of a Bigelow's evacuator, and by means of the evacuator withdraw the blood-clot. This treatment is occasionally satisfactory. The introduction of these large instruments may cause fresh bleeding, and there is some risk in injecting more fluid by means of the powerful rubber bulb into a bladder already distended ; it is often better to open the bladder suprapubically without delay.

Retention following Injuries to the Perineum.—In all cases where there is reason to suspect injury to the urethra, the first step should be an attempt to introduce a catheter ; a *coudé* gum-elastic instrument will be found more serviceable than any other. Should such introduction fail, external urethrotomy should be performed at once. If the catheter has been passed into the bladder, it is better to tie it in, at least for twenty-four hours. Of course, if there appears to be merely a slight urethral bruising, this step need not be adopted, and it is well to be guided by the amount of bleeding that has taken place from the urethra and the amount of difficulty experienced in the introduction of the instrument. In all cases where a catheter has been tied in, the closest watch must be kept over the perineum for signs of peri-urethral suppuration.

Retention due to Spasm without any gross organic mischief in the urethra is diagnosed by means of the urethroscope ; it is best treated by bromides and belladonna and the occasional passage of a large metal bougie.

Hysterical and Post-operative Retention must not be confounded with suppression of urine. Instruments should not be used until various domestic remedies have been tried.

A Phosphatic Calculus in the prostatic cavity must be removed by opening up the suprapubic wound.

When retention occurs during the course of **Nervous Diseases,** we have to deal with a condition of affairs very different from the preceding varieties. In many cases the retention is a permanent malady ; in others, weeks or months may elapse before the catheter can be dispensed with. The greatest care must be taken to avoid sepsis. (*See* 'Injuries to the Spine,' p. 190.)

RUPTURE OF THE URETHRA AND EXTRAVASATION OF URINE.

There are two main causes of extravasation of urine. The first is the infliction of some injury to the perineum ; the second is due to the gradual weakening or increasing rottenness of the tube, caused by low inflammatory changes following on an old-standing stricture, with a more or less complete retention.

In both cases the extravasation is strictly a 'surgical emergency,' and requires prompt and decided treatment.

Traumatic Rupture of the Urethra.—It will be found that these cases are mostly caused by a heavy fall on the crutch, or by a kick or blow there, but they may be due to an incised or punctured wound. The *symptoms* pointing to an injury of the urethra are a constant and extreme desire to pass water, with inability to do so, or at least only in a few drops, while there is a varying amount of hæmorrhage from the meatus. There are also bruising and great tenderness in the perineum. These symptoms indicate that the urethra has been torn, and unless a catheter can be immediately passed, and kept in the bladder, symptoms of extravasation will soon occur.

Under no circumstances should the patient be allowed to pass his water, if it can be prevented, until the state of the urethra has been investigated.

Management of Catheter.—In the first place then, a very gentle and patient attempt should be made to pass a catheter, using by preference a No. 8 or 9 soft, olivary-shaped one, or better still, a *coudé* instrument, and if this fails, a silver one, taking particular care to keep *along the roof of the canal.*

If a moderate-sized catheter will not pass, a smaller one may be tried, but will probably fail to get through, and the attempt must not be persisted in.

In the fortunate event of an instrument having been passed into the bladder, it should be tied in, in the manner already described, and

the after-treatment of the case may be left to the visiting surgeon. The patient will, in most cases, do well.

But very often it is not possible to pass an instrument. In this case it would be unwise to wait for any length of time, for extravasation of urine might take place and put the patient in a very hazardous position. A house surgeon should therefore send for his chief, and make all preparations for the operation described below.

Technique of Operation.—In all cases of rupture of the urethra severe enough to need operation, the bladder should be opened by a suprapubic incision, and a silk elastic catheter passed from the bladder along the urethra to the rupture. A similar or a soft rubber catheter is passed from the external urethral orifice down to the rupture (*Plate VI, Fig. A*). The patient is then placed in the lithotomy position, the table being tilted so that the perineum is almost horizontal. An incision is made in the mid-line of the perineum, and the ends of the two catheters are found and drawn into the wound (*Plate VI, Fig. B*). The 'bladder' catheter is attached to the 'penile' catheter and withdrawn, drawing the penile catheter across the rupture into the bladder (*Plate VII, Figs. C* and *D*). The tear can then be sutured around the catheter or left unsutured as the surgeon prefers. The bladder should be drained by a de Pezzer tube for a week, and the perineal wound left open.

A median incision made early will often be sufficient to prevent further extravasation, but it frequently happens that the patient is not seen until the urine has made its way into the scrotum, and may be traced, travelling along the folds of the groin upwards on to the abdomen, its progress being marked by a dusky brawny infiltration.

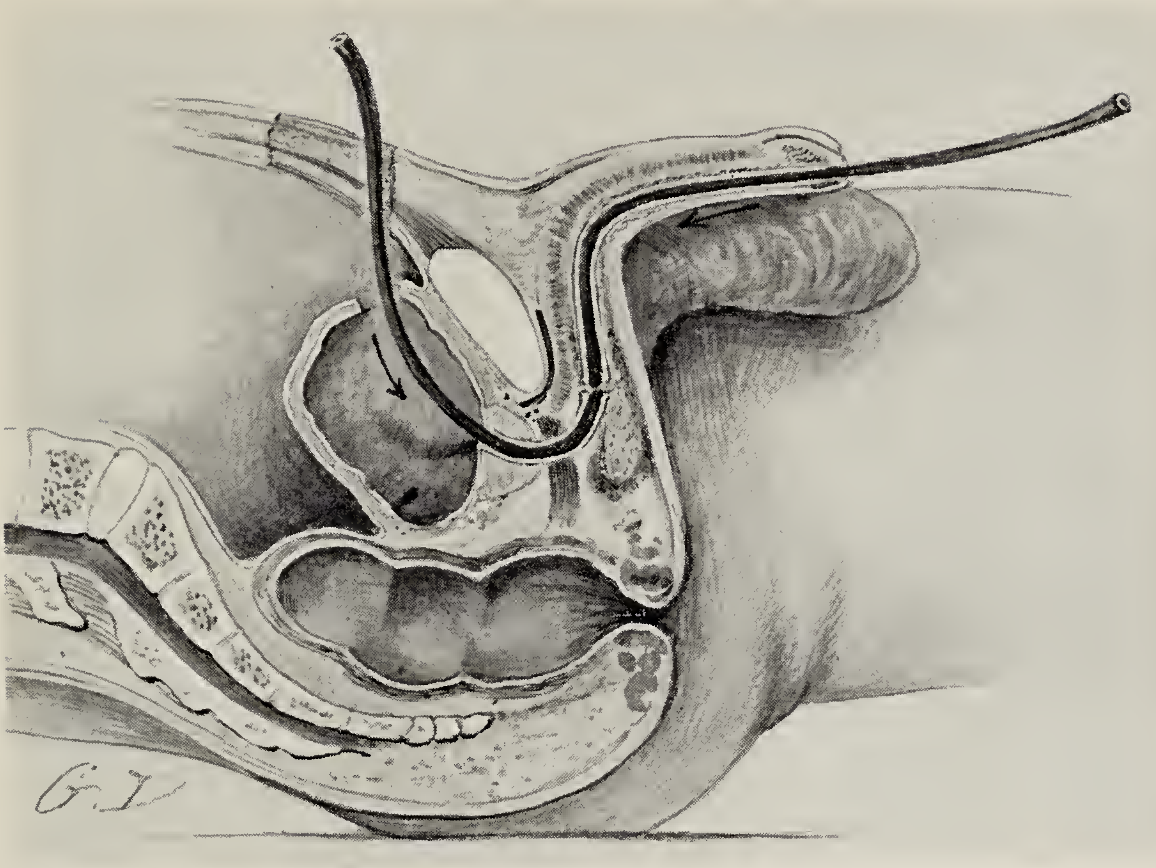
The anatomical reasons why the usual traumatic rupture of the urethra in front of the triangular ligament is followed by extravasation into the scrotum and upwards on to the abdomen, but not down towards the thighs, are well known. But cases do sometimes occur of rupture between the layers of the ligament ; the urine will then travel in a different direction.

Free incisions wherever the tissues are involved offer, in such a case, the only chance of preventing the most extensive sloughing, with all the attendant risks of septicæmia. The median one in the perineum should never be omitted, but in addition, the scrotum and penis may have to be incised in two or three places, while the same relief will frequently have to be afforded to the skin of the lower part of the abdomen. In spite of all, however, some sloughing is sure to occur, and this, with the smell caused by the constant escape of urine, generally makes it desirable that the patient should be isolated.

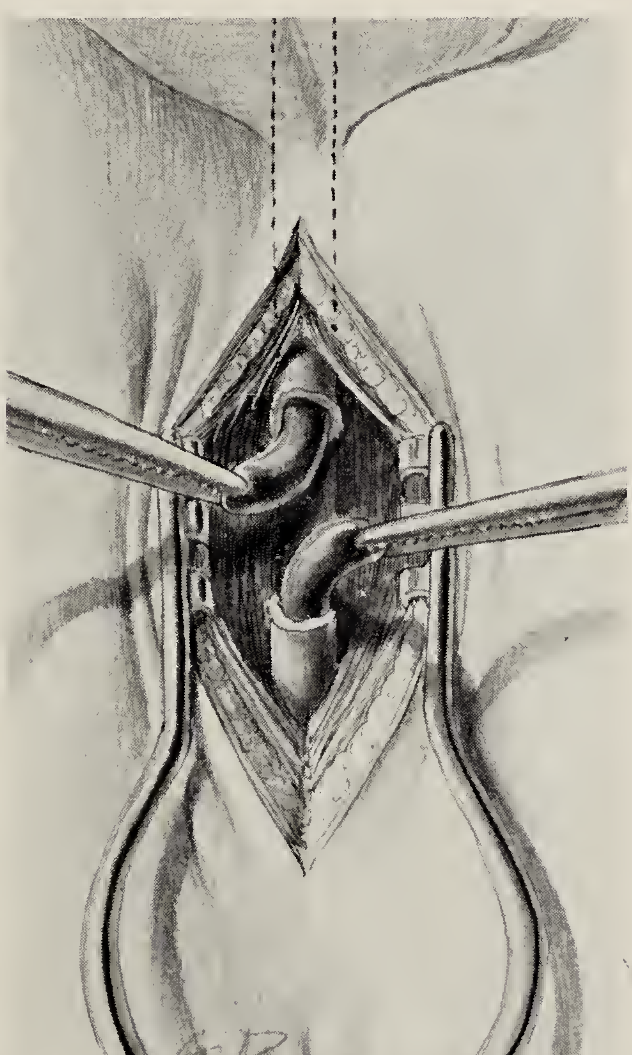
The parts may be fomented well with boric lint or some mild antiseptic preparation. Frequent washing and syringing with permanganate of potash or carbolic acid lotions will be called for, and as soon

PLATE VI

OPERATION FOR RUPTURED URETHRA



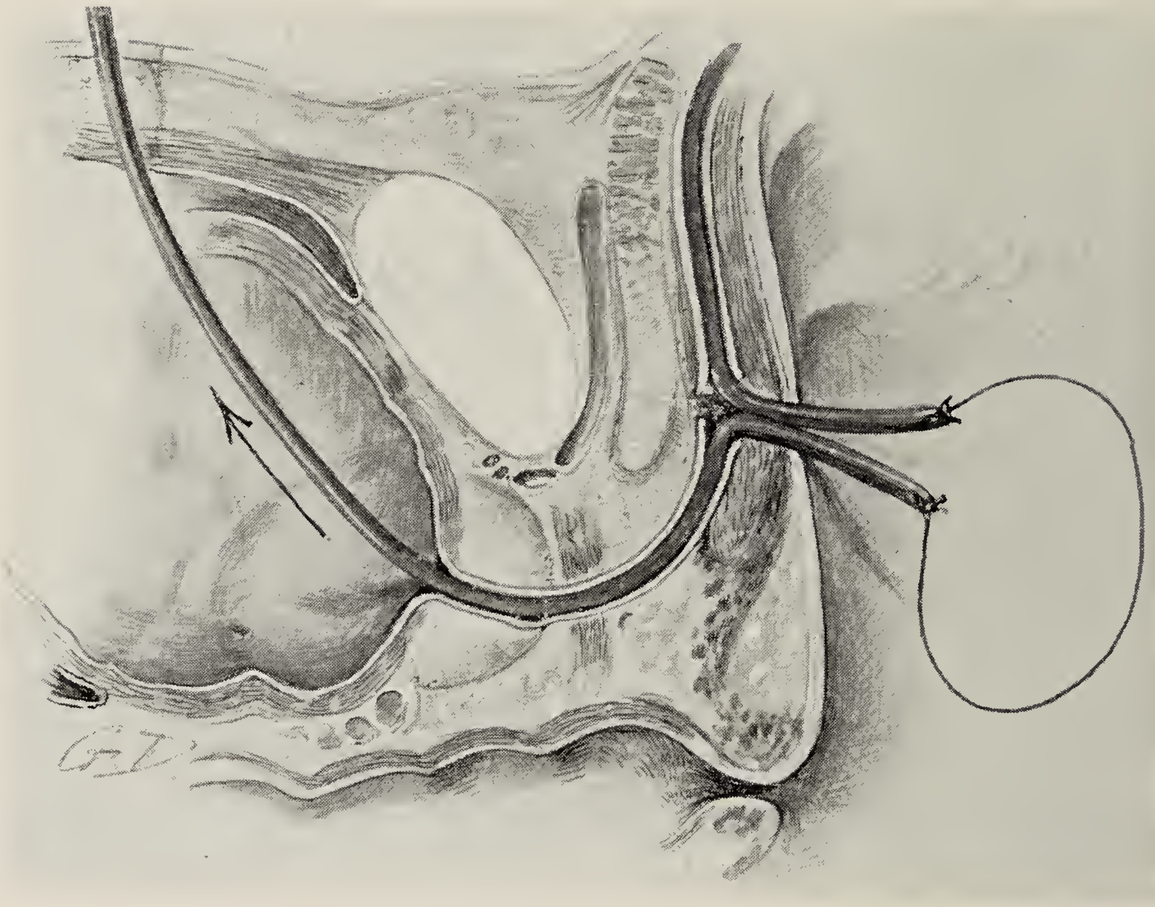
A.—Sagittal diagram showing the two catheters meeting at point of rupture



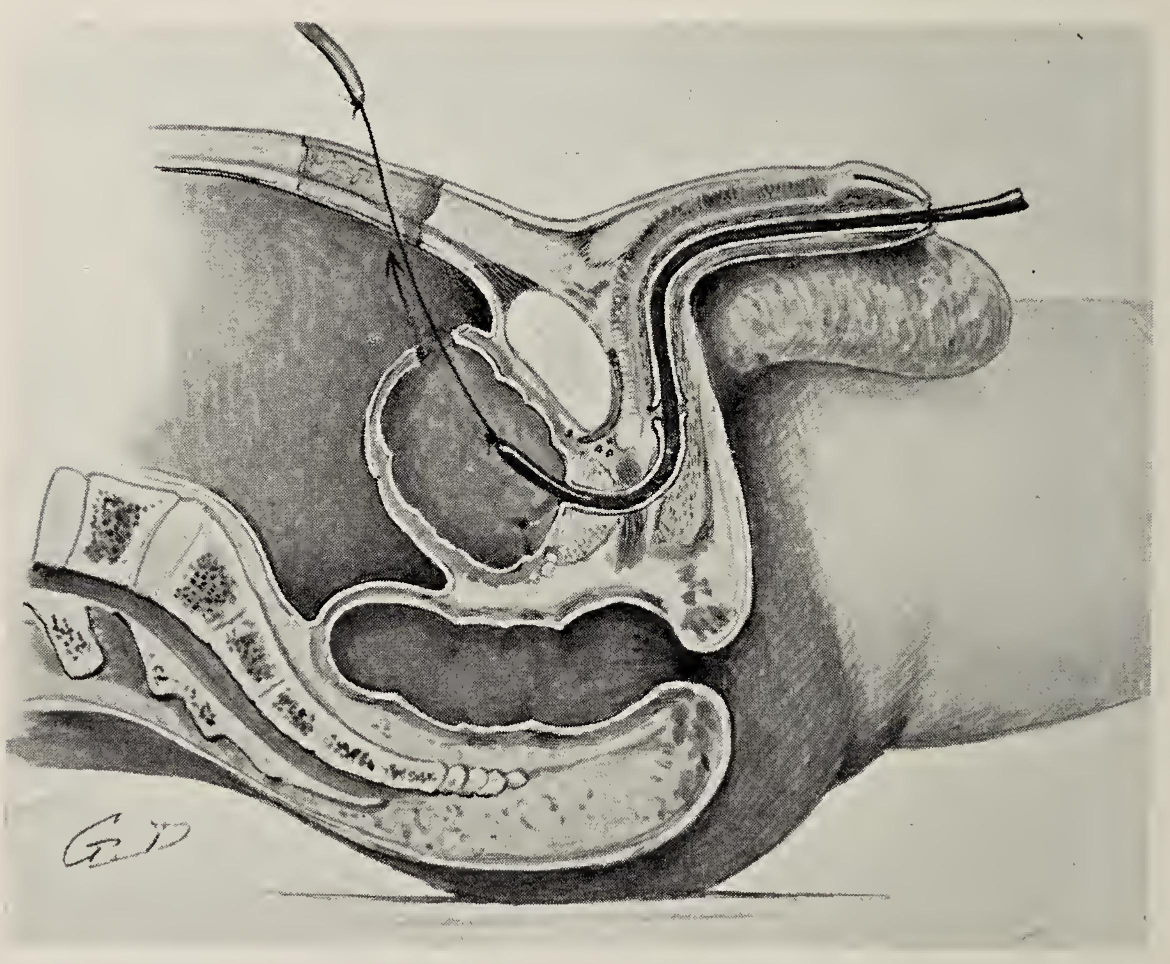
B.—The two catheters exposed on perineal section.

PLATE VII

OPERATION FOR RUPTURED URETHRA



C.—The catheters withdrawn through the perineal wound and sewn together.



D.—The 'bladder' catheter is withdrawn, drawing the 'penile' catheter into position.

as the patient is able to do so, he should frequently sit in a bath of weak warm permanganate of potash or boric acid.

Extravasation as a Result of Stricture.—The other fashion in which the urethral walls may give way occurs when a long-standing and neglected stricture produces a condition of partial or (more rarely) of complete retention. A low form of inflammatory softening of the walls of the canal takes place, and, distended beyond their power of resistance in that condition, they give way ; the result is the formation of urinary abscesses and extravasation. The symptoms do not differ materially from the traumatic form, save in this, that the extravasation commences as soon as the urethra gives way, whereas in the traumatic cases there is no escape of urine until the patient attempts to pass water. It must be clearly understood that in many cases the symptoms of extravasation come on gradually. The first manifestation of a urethral leakage may be a tender swelling in the perineum, or peri-urethral abscess.

Peri-urethral Abscess.—There are three common causes for this condition : (1) Gonorrhœa (considered on pp. 384 and 389) ; (2) Prostatic abscess which tracks down into the perineum ; (3) Extravasation behind a stricture. It is most essential that the cause of the abscess should be recognized as soon as possible, as the treatment differs in the three cases.

In the case of a prostatic abscess, rectal examination will reveal a swollen tender prostate, and the pus must be evacuated by a deep perineal incision ; it is not always necessary to open the urethra.

But when a peri-urethral abscess arises from softening of the urethra behind a stricture, the patient's history, and an examination of the canal with a sound, or better, the urethroscope, will give sufficient information. The treatment to be adopted is free incision of the abscess ; external urethrotomy may or may not be called for.

As regards the treatment of extravasation due to stricture, the question of the passage of an instrument should be left to the discretion of the visiting surgeon, for, as a rule, the tissues are not in a condition to allow of successful catheterization until the operation of perineal section has been performed, and further damage may easily be done in the attempt. But there must be no hesitation or delay in relieving the extravasation by free incisions, whenever they are required, the one in the middle line of the perineum being, as before, the most important.

The prognosis in these cases is unfavourable. From the nature of the disease it follows that the patient is broken down constitutionally ; very probably his kidneys are diseased—'surgical kidneys' —and the infiltration, suppuration, and sloughing which result are apt to bring about a condition of septicæmia which is generally fatal. In any case stimulants, such as alcohol, carbonate of ammonia, etc., and a generous diet will be required, while with regard to the local dressing, the management will be similar to that which was advised for traumatic cases.

We do not here consider the surgical questions which arise in connection with the urinary fistulæ which so often are the result of extravasation, however produced.

RUPTURE OF THE BLADDER.

This is a form of injury frequently met with in the accident wards of a hospital, and although the active treatment of the injury belongs to major surgery, the recognition of this serious lesion is the duty of the house surgeon.

Rupture is often produced by a fall or a blow on the abdomen when the organ is in a state of distention, but the accident may accompany a crush or fracture of the pelvis ; indeed, the most serious forms of injury are associated with this condition.

In any case when a patient has fallen from a great height, or has been crushed or run over, it is the duty of the house surgeon to ascertain as soon as possible whether the bladder has been damaged.

The rupture may involve the peritoneal or non-peritoneal surface of the viscus ; and although it may not be possible at first to distinguish between these two varieties of injury, some information can be obtained on examination which will make it clear that the bladder has been lacerated. There is usually profound shock, and as this condition in itself may lead to a temporary cessation of the renal function, the fact that the patient is unable to pass water does not attract the attention due to it. In some cases where the rupture is extra-peritoneal, there is an intense desire to micturate, but inability to do so.

Supposing then that a patient is brought in after a severe crush between the buffers of a train, a careful examination is made of the pelvis in order to ascertain if the bones are broken. The next step in any case is to pass a gum-elastic catheter into the bladder. Should blood-stained urine be withdrawn, there is strong but not conclusive evidence that the bladder has been injured ; the blood may come from a bruised or lacerated kidney. (*See* 'Fractures of the Pelvis,' p. 158.)

SUPPRESSION OF URINE.

It sometimes happens that in the course of his surgical work a house surgeon is called upon to deal with a case of suppression of urine. Of the many causes which lead to the condition, stricture and prostatic enlargement are the most common, apart of course from the various medical forms of nephritis. It is quite beyond the scope of this work to discuss all the conditions which may give rise to suppression of urine, or anuria, but a brief list will be given, and the non-operative treatment of suppression considered in detail.

Obstructive Suppression occurs when both ureters or the ureter of a single working kidney become blocked by a calculus, and the same result occurs when the ureters become entangled in a malignant growth.

The special point is the prompt recognition of the condition, which although rare is occasionally met with.

Non-obstructive Anuria occurs in many different forms.

In *Anuria from Nephritis*, the tubules of the kidney become choked by inflammatory débris, and a partial or total suppression of function supervenes.

Reflex Anuria occurs after renal and abdominal operations, or after some operation on the urinary tract—it may be only the passage of a catheter, or a more severe proceeding such as urethrotomy or prostatectomy.

It is this last form of suppression which will be considered. It must be borne in mind that patients who have suffered for any length of time from stricture, stone, or prostatic enlargement, have sustained a certain amount of damage to their kidneys. They are therefore less able to withstand any operative procedure than an individual who is free from these disorders.

The treatment may be considered from two points of view : (1) Prophylactic treatment, directed to minimize the chances of the supervention of suppression ; (2) The treatment of suppression when once it is established.

1. The greatest attention should be paid to the preparation of all cases of stricture and enlarged prostate before any operative procedure ; every effort should be made to improve the condition of the kidneys by drugs and dieting, and the vicarious action of the skin and bowels in carrying off the excretions encouraged to the fullest extent. Warmth and quiet are absolute essentials.

Digitalis and hexamine are exceedingly valuable, and the diet should consist of milk with a fair amount of diluent drink, such as distilled water, barley-water, and linseed-tea. It has been urged that diuretics should be prohibited, as tending to overstrain the damaged kidneys. We do not hold this view, especially if the diuretics are harmless and sedative, as barley-water and linseed-tea. As a rule, in the damaged kidney there is no difficulty in the watery element of the urine making its exit : the trouble is with the urea and extractives ; dilution will assist the kidney in getting rid of them, and a certain increase in the fluid of the blood will favour diaphoresis and free purgation.

It is a natural corollary from these precautions that, if renal inadequacy is recognized, operative treatment should be condemned as being likely to precipitate anuria.

But in practice it is necessary to bear in mind that the cause of the renal disease, if left alone, will itself shortly bring about a fatal issue ; in other words, that stricture and enlarged prostate, if not relieved, will end in death. It is not always possible to form an opinion, upon examination of the urine, as to the patient's chances of surviving an operation. At the same time the urine in a case of genito-urinary disease should be submitted to the most careful examination.

Renal Function Tests.—Two methods are in constant use to determine the excretory power of the kidneys. They are the urea concentration test and the estimation of the blood-urea. The urea concentration test can be easily done by the house surgeon, but the blood-urea estimation should be done in the biochemical laboratory.

Urea Concentration Test.—The bladder is emptied by catheter; 15 grm. (225 gr.) of urea are given by the mouth in a glassful of barley water. The urine is drawn off every hour for 4 hours, and each specimen quantitatively tested for urea and compared with the reading before the administration of urea. If the kidney function is normal, the urea should reach 2·5 or 2·75 per cent after the second hour. If the urea does not reach 1·5 per cent in any test, a two-stage operation—that is, a preliminary drainage of the bladder—is indicated.

The blood-urea should not exceed 30 mgrm. per cent; if over 50 a one-stage operation is contra-indicated.

2. If a patient, shortly after the passage of a catheter or after an operation, has a rigor, the house surgeon should at once become suspicious about his case. The urine should, if possible, be collected, and if there is a diminution in the amount passed, suppression is to be feared. The first thing to do is to get the bowels well open with a drachm of pulv. jalapæ co., or 5 gr. of calomel, and to apply dry cups or linseed poultices over the loins. These are simple and most efficient remedies, prompt recourse to which has saved many cases. Digitalis may be given, but sparteine sulphate in 2-gr. doses hypodermically is now said to give better results.

If, in spite of all, absolute suppression intervenes, the house surgeon must give his patient a hot pack, the cupping being repeated subsequently.

The hot pack is given as follows: The patient is wrapped up in a blanket, and lies on a mackintosh sheet. A cradle covered with a blanket and a mackintosh is placed over him, so that only his head is exposed. A series of incandescent lamps are hung inside the cradle, and by switching on one or more any required temperature may be obtained. More elaborate apparatuses are obtainable, but the method described can always be put into operation at a moment's notice. A thermometer should be placed underneath the cradle, and the temperature should be raised to 120°. It is sometimes necessary to allow a higher point to be reached if free sweating does not occur, but 120° may be taken as a usual temperature.

The patient should be kept in the apparatus for twenty minutes to half an hour; from time to time the forehead should be felt to ascertain if the skin is acting freely, and the state of the temporal pulse noted, since there is some risk of cardiac failure. Stimulants—brandy and strychnine—should be at hand in case this supervenes. When the skin is acting freely the cradle is removed, and the patient is wrapped up in warm dry blankets and covered up. The object of

the bath is to induce the skin to carry off the products of metabolism with which the kidneys are unable to deal, and it is a very valuable remedy. During the time the patient is being thus treated he should be given diuretics, barley-water, etc.

Pilocarpine is sometimes employed ; it is a dangerous drug, and its use must depend upon the opinion of the surgeon in charge of the case.

The infusion of saline into the veins has sometimes been successful in promoting diuresis ; it may be tried, but not until the bowels have acted thoroughly, and it must be done with care, as there is already an increase of vascular tension present in these cases; a better remedy is a 5 per cent solution of glucose, which is isotonic and a powerful diuretic.

CHAPTER XXXVIII

OF THE USE OF THE STOMACH PUMP, ETC., AND OF HYPODERMIC INJECTION

WASHING out of the Stomach: use of the Stomach Pump.—The use of the stomach pump in cases of poisoning is several times alluded to in the chapter dealing with that subject, but it is employed on many other occasions as well, as for the feeding of refractory patients, or in the treatment of some forms of dyspepsia.

There are several forms of the pump, but a very common and convenient one is that here figured (*Fig.* 233), which can also be used as an aspirator. It is made on what is known as the 'flute-key' principle, and its action can be readily understood from the illustration. The tap of the pump is a two-wayed one, and if the piston were to be drawn out while the lever at the top in the figure remained in the position in which it is drawn, fluid would be sucked into the cylinder from the vertical tube, and similarly expelled by that tube if the piston were afterwards pushed in. But if the lever be depressed, the vertical tube will be shut off, and the horizontal one will now be in communication with the cylinder and piston; so that, by depressing and raising the lever synchronously with the to-and-fro movement of the piston, fluids may be sucked from the vertical tube, and expelled by the horizontal one, or *vice versa*, according to the relative position of the lever and piston.

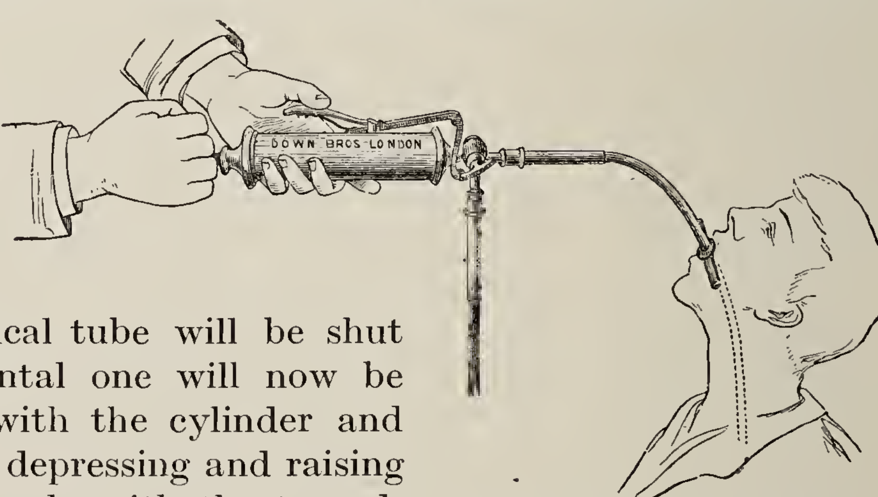


Fig. 233.—Flute-keyed Stomach Pump and Aspirator combined.

Insertion of the Tube.—This is the important point in the use of the stomach pump. In restless or refractory patients it will be necessary to use a gag, and although almost any form will do, the best is a piece of hard wood, of such a size that it will lie across the mouth between the front molar teeth, and it should be broad enough to allow of a hole being bored through its centre, through which the tube can be passed.

In other cases no gag is required, and then the tube, which is made of gum-elastic, having been well warmed and softened, can be passed

with the right hand and guided by the left forefinger through the pharynx and down the gullet, with much greater ease. As soon as the end of the tube enters the œsophagus the choking usually stops. Supposing the case to be one in which the removal of something hurtful from the stomach is the object of the operation, after the tube has been passed, not less than half a pint of warm water, or of some special fluid, must be injected into the stomach before anything is sucked from it. The stomach may then safely be emptied, and the process of injection and suction repeated until the object is attained.

In cases of Poisoning, a pint of water, or of some bland, soothing fluid, should be left in the stomach ; as also in the case of simple drunkenness, unless it be desired to leave an emetic injection instead. If, however, the pump has been employed for the purpose of washing the mucous membrane, and removing the fermenting secretions of waterbrash, or similar forms of dyspepsia, only that amount of fluid should be left behind which the pump will not readily remove.

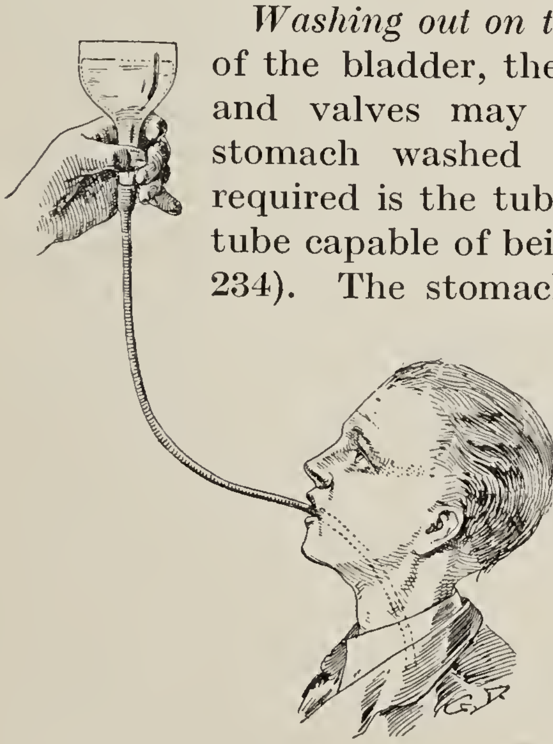


Fig. 234.—Funnel and Tube.

Washing out on the Syphon System.—But, as in the case of the bladder, the mechanism of a syringe with its taps and valves may be readily dispensed with, and the stomach washed out very easily indeed. All that is required is the tube of the stomach pump, an indiarubber tube capable of being attached to this, and a funnel (*Fig.* 234). The stomach tube having been passed, tube and funnel are joined on, and then, by alternately pouring in fluid (the funnel being held about 2ft. 6in. above the level of the stomach) and then removing it by lowering the tube to an equal distance below, the operation of washing out the stomach can be reduced to its simplest conditions ; but a certain amount of stiffness in the tube is essential.

Œsophageal Bougies are employed for the purpose of dilatation of simple strictures in this canal. They are also used for the purpose of diagnosis. With regard to their shape, etc., the best form is the olivary, as in urethral bougies, the medium and larger sizes of which are frequently used for the œsophagus, although of course much larger sizes still are commonly employed. *No œsophageal bougie should ever be passed until an examination of the thorax excludes an aortic aneurysm.*

An œsophageal bougie should always be passed with very great care, and in cases of suspected malignant disease, or, indeed, in all cases where the cause of the œsophageal obstruction is obscure, the house surgeon will not be justified in using this instrument on his own responsibility. On the other hand, it may be his duty, acting under

his senior's instructions, regularly to dilate an œsophageal stricture by bougies. With regard to the actual passage, the manipulation is the same as for the tube of the stomach pump, the left forefinger being used as a guide, while the well-warmed bougie is passed with the right hand. But the utmost gentleness must be exercised while the bougie is in contact with the stricture.

Hypodermic Injection. — As we have been considering questions involving the use of various forms of syringes, this will be as convenient an opportunity as any to consider the performance of *hypodermic injection.* This method of administration was first introduced by Wood, and has been applied to a very large range of drugs, and also to stimulants, as strychnine and brandy.

The syringe is also very commonly employed, not strictly hypodermically, for the purposes of diagnosis or for the removal of small collections of fluid.

The number of drugs exhibited for this purpose has increased very greatly of recent years, and convenient tabloids, etc., of accurately weighed amounts, are now sold by most manufacturing chemists. The convenience of having the drugs in such a handy and portable form has been much appreciated by the medical profession. But inasmuch as the injection of morphia is so much more common than that of all the rest, and since the actual performance of the injection is almost the same in all cases, it will suffice for us to describe the rules for morphia injection.

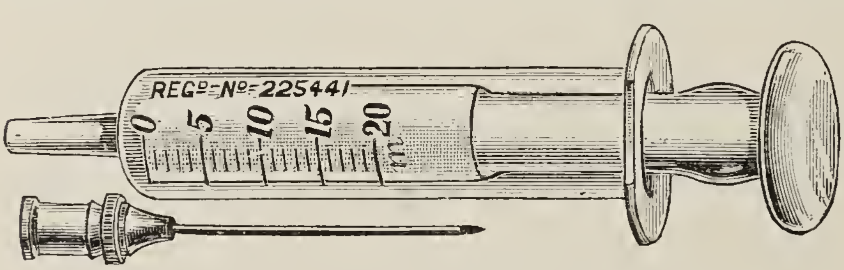


Fig. 235.—All-glass Hypodermic Syringe.

The Hypodermic Syringe.—There are a number of patterns of hypodermic syringes, but their varieties involve no real difference of principle. They are all graduated to deliver the fluid to be injected by measured drops, and it matters little if this be effected by a screw or a thrust piston.

All-glass syringes (*Fig.* 235) have now come into general use, and they are to be strongly recommended, as they can be thoroughly sterilized by boiling. The needles should be kept in methylated spirit to prevent rusting.

The special points to be observed in connection with hypodermic injection are :—

1. The skin should be cleaned with a little alcohol.

2. The needle should be thrust into the subcutaneous tissue at some place where it is loose and where the skin is free from veins (unless it is desired to inject into the vein cavity, as in the injection of ether for extreme syncope, or of ammonia for snake-bites).

The fluid having been injected, the needle should be withdrawn quickly, and then, the puncture being covered by the point of the

finger, the injected fluid should be dispersed into the tissues by gentle rubbing.

3. Every now and again it happens that the administration of morphia in this way is followed by somewhat alarming symptoms of flushing, general pruritus, buzzing in the ears, and other signs of vaso-motor disturbance, which somewhat resemble the commencement of an apoplectic fit. This derangement seems never to produce any permanent mischief, but it is well to be warned of it, lest it should produce undue alarm. The dose of the morphia does not seem to influence the occurrence.

After using the syringe, the needle should be cleaned by passing through a flame, and the silver or gold wire replaced in the needle to prevent rusting.

The introduction of the injection of antitoxins for the treatment of diphtheria and other diseases has necessitated the use of syringes made of glass, like the hypodermic syringes, but much larger. They are generally marked in cubic centimetres and not in minims.

Cases of diphtheria are generally placed under the care of a house physician rather than a house surgeon, but the latter may be called upon to use the antitoxin serum for septicæmia or tetanus. The dose that is injected will of course depend on the strength of the antitoxin, but as a rule 5 to 10 c.c. is about the amount used.

4. Lastly, and this point we would most strongly insist upon : no surgeon, house surgeon, or dresser should ever be induced to instruct a patient, or any one of the laity, in the art of self-injection. A syringe and a bottle of morphia are tools far too unsafe, and far too seductive, to leave in hands where they may be tampered with, and used, it may be unwittingly, as agents for self-destruction.

CHAPTER XXXIX

ON THE EXAMINATION OF THE RECTUM, AND THE USE OF BOUGIES, ENEMATA, ETC.

THE **Examination of the Rectum** may be conducted either digitally or instrumentally. In the latter case we make use of various forms of specula, which enable the examiner to inspect the lumen of the bowel ; or the sigmoidoscope, which allows of inspection of the canal up to the sigmoid flexure.

While considerable importance is to be attached to the use of the sigmoidoscope, the mode of employment will be considered later. It is especially the digital examination which the house surgeon will require. No part of the routine examination of a patient is of more importance in many diseases, and, unfortunately, no detail is so often omitted as this.

In the first place, it must be remembered that there are two principal methods of examining the rectum :—

1. With the patient lying on the back or side : the position usually adopted.

2. With the patient in the knee-elbow position, the buttocks well raised. The examiner introduces his finger into the bowel, directing it backwards into the hollow of the sacrum. With a little patience and gentle pressure the finger can be well introduced, and is then swept round the bowel, and various conditions on the front, back, and sides are carefully noted. It is better to be a little below the level of the patient's buttock, and to hold the hand nearly vertical.

Of course, such an examination is rarely possible in the female, so one must rest content with the former and less effective method.

If, when the finger has been well introduced, the patient be told to bear down or strain, an inch or two more of the gut will be accessible to examination.

Some patients have the greatest dislike to this method of investigation, and it is always advisable to explain to them the necessity for the step.

It may be of advantage to the student to consider some of the information that may be gathered by a careful rectal examination, and some of the conditions in which it is called for :—

1. In all cases of hæmorrhage from the rectum the finger may detect hæmorrhoids, polypus, prolapse, cancer, stricture.

If a fissure is found on inspection of the anus, it is better not to insist on making a digital examination until the patient is anæsthetized for treatment, as the proceeding is excessively painful.

In every case of hæmorrhoids the rectum must be carefully examined, since hæmorrhoids sometimes are the first and only sign of cancer.

In cases of stricture there are usually a number of fistulous openings round the anus, and the finger will encounter a very tight obstruction.

In ischiorectal suppuration, a foreign body may be detected.

2. In pelvic diseases in young unmarried women, a rectal examination in preference to a vaginal is made in order to ascertain the state of the ovaries and tubes.

3. In cases of suspected stone in the bladder, especially in children. In some cases the size of the stone can be accurately estimated between a finger in the rectum and a sound in the bladder.

4. In cases when the diagnosis between cystitis and pyelitis is difficult, tenderness of the bladder, as noticed on rectal examination, will be a point in favour of the former lesion.

5. In all cases of suspected enlargement of the prostate, the nature of the enlargement, whether simple, inflammatory, or malignant, can be made out.

6. In all cases of retention of urine when any doubt exists as to the cause.

7. In peri-urethral suppuration, to learn the state of the prostate.

8. In chronic urethritis or gleet, which is often due to prostatitis or inflammation of the seminal vesicles.

9. In all cases of intestinal obstruction (it is especially valuable in intussusception).

10. In cases of acute abdominal lesions when appendicitis or pyosalpinx is suspected.

11. In advanced cases of hip-joint disease up to the twenty-first year, since the acetabulum may become eroded and a pelvic abscess caused by the spread of the disease through the bone.

12. In all cases of sciatica, since this may be a symptom of carcinoma of the rectum or prostate.

13. In serious injuries to the pelvis or hip, to ascertain if the bowel is damaged.

14. In tuberculous disease of the epididymis, in order to note whether there is any thickening of the prostate or vesiculæ seminales : a point of importance not only in treatment but in diagnosis.

15. In cases of renal colic or suppression of urine, when it is thought that a stone may be impacted in the lower end of the ureter.

It will be seen from the above that much valuable information about various diseases may be obtained by rectal examination.

The Passage of Rectal Bougies, Enemata, etc.—Bougies are frequently employed in the treatment of simple and syphilitic strictures of the rectum. These instruments are made of flexible gum-elastic, vulcanite, metal, or wax. They are arranged in graduated sizes, and are either cylindrical or conical. Their passage is almost always painful, but wax bougies give the least suffering, and metal ones the

most ; those of gum-elastic are in most common use. They should be warmed and oiled, and are best introduced while the patient lies on the left side. The right forefinger should be passed up to the stricture, and then the bougie passed along it, and thus guided into the aperture. No force should ever be used. As a rule the instrument is allowed to remain in some ten minutes or quarter of an hour ; if the pain be great, a morphia suppository may be given either half an hour before the introduction or immediately after the withdrawal.

This method when very painful should bc commenced under an anæsthetic, when existing fistulæ can be laid open or scraped.

The patient should be confined to bed during the early days of this treatment, the diet should be sparing, and the rectum should be frequently washed out with weak Condy's fluid or some non-irritating antiseptic.

If diarrhœa is present it may be necessary to check it by the use of starch and opium enemata, which will also have some anæsthetic action.

Smart bleeding often accompanies the operation, but it is readily checked with hot water. It is not advisable to dilate to any great extent the first time, since the efficacy of the treatment depends

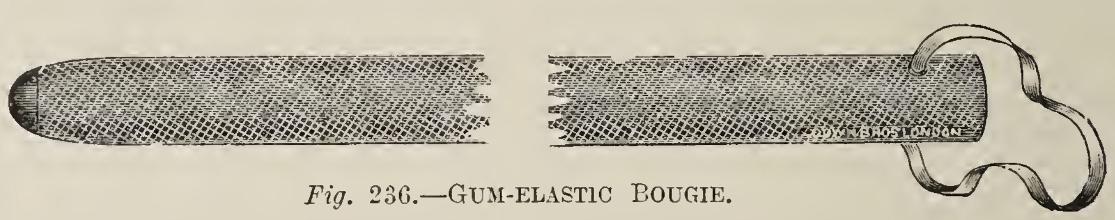


Fig. 236.—GUM-ELASTIC BOUGIE.

not so much upon the amount of stretching as upon its frequent application ; while if, previous to the operation, the patient makes use of a hot hip-bath, the dilatation will be facilitated.

Two days afterwards a small bougie, smeared with cocaine ointment, 1 per cent, should be carefully introduced, and left *in situ* for a period of half to one hour if it does not produce undue pain, after which it will be found that the rectum becomes increasingly tolerant, and in a week it will bear a full-sized instrument.

It is, of course, clear that such treatment is in the main palliative ; for if it is not maintained for a long period, and repeated at regular intervals, the narrowing is bound to recur.

Enemata, or Clysters as they were called, consist of various drugs or foods injected into the bowel for different purposes.

We may divide enemata into several groups :—

Purgative, for causing an evacuation of the bowels ; *Astringent*, a means of locally treating inflamed states of the rectum and colon ; *Nutrient*, to give a patient food when the stomach is unable to retain it ; *Stimulant*, to combat shock and collapse ; *Sedative*, to quiet the bowel or the bladder in some inflammatory states.

Purgative Enemata. — We have a large number of enemata in common use, their main object being to dislodge fæces or flatus from the intestine.

1. *Enema Saponis* consists of a solution of soap and warm water used for the ordinary washing out of the bowel.

2. *Enema Olei Terebinthinæ* is a solution of gruel or starch containing ½ oz. to 1 oz. turpentine to the pint. It is exceedingly useful in the treatment of meteorism, especially if combined with 15 gr. of asafœtida.

3. *Enema Olei Olivi* is used for cases of obstinate constipation when there are a number of scybalous masses which cannot be passed. If ox-bile be added to the oil in equal parts a greater effect is produced.

4. *Enema Glycerini.*—An injection of glycerin, either with or without other drugs, such as castor oil, is very serviceable in assisting an atonic bowel to expel its contents.

The general principle upon which all these enemata are used is the same, with the exception of the glycerin variety. Our object is to introduce them high up into the sigmoid, so that peristalsis may be set up and the hardened contents of the bowel softened before evacuation. Glycerin acts locally on the rectum, and is given in much smaller quantities.

A pint is the amount of an ordinary enema ; but in adults as much as two pints may be given ; in children, of course, much less.

In administering an enema the following precautions are to be observed. Prepare the enema, making sure that the solution is properly warmed (75° to 85° F.), pass the rectal tube well up into the bowel, and make the patient lie on his right side with the buttocks slightly elevated. *Inject very slowly.* An irrigator is much better than a Higginson's syringe. It takes half an hour to give an oil injection properly.

If the enema is retained, the administration of a small glycerin injection will usually cause its expulsion.

Astringent Enemata are given for the treatment of chronic colitis, hæmorrhage from the bowel, and for local conditions such as worms.

The commoner varieties are : Solutions of nitrate of silver, 1–1000 to 1–500 ; iced solutions of hamamelis ; infusion of quassia ; or solution of alum.

They are given in the same way as the others, only the buttocks should be raised well above the level of the rest of the body when it is desired that the colon be irrigated.

Nutrient Enemata are usually given after severe operations, when the patient is unable to swallow, or in diseased states of the stomach. It is sometimes necessary to employ them when there is severe post-anæsthetic vomiting. There is a good deal of discussion as to their actual value, and there is reason to believe that much larger nutrient enemata may be given with advantage than is the usual practice.

An ordinary nutrient enema consists of :—

℞	Yolk of 1 Egg		Brandy	℥ss
	Beef Tea or Milk	℥j	Liq. Pancreaticus	ʒij

The bowel is first washed out with a soap-and-water or saline injection, after which the nutrient is introduced. At the end of four hours the bowel is again washed out and the injection repeated.

Stimulant Enemata are given for the relief of severe shock and bodily depression. They consist for the most of normal saline to which brandy (1 oz. to the pint) or strong coffee has been added. A pint or more should be given if necessary every four hours. (*See* 'Saline Injection per Rectum', p. 55.)

Sedative Enemata consist of preparations of opium combined with starch or other excipient. A very useful form is :—

℞ Tinct. Opii ♏xx | Starch Mucilage ℥iv or vj

This is given for severe diarrhœa and tenesmus. Chloral hydrate and bromide of potassium, 30 gr. of each, are also given per rectum at the beginning of the treatment of tetanus.

The Sigmoidoscope is a modern instrument which was introduced by Strauss. It enables us to examine a considerable extent of the sigmoid flexure as well as the rectum. In this manner cases of

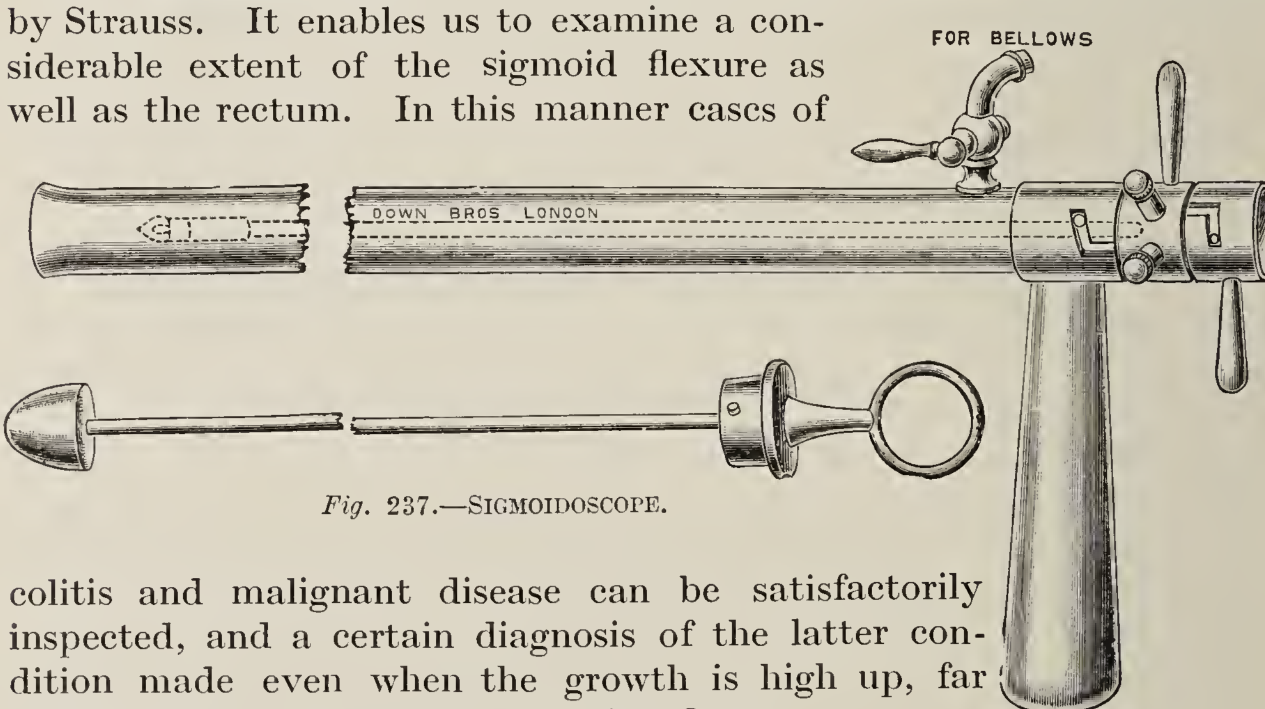


Fig. 237.—SIGMOIDOSCOPE.

colitis and malignant disease can be satisfactorily inspected, and a certain diagnosis of the latter condition made even when the growth is high up, far beyond the reach of the examining finger.

The instrument is of use in investigating cases of obscure hæmorrhage for which no cause can be found low down.

The sigmoidoscope consists of a long metal tube with a bulbous extremity, into which fits a rounded metal plug. This rounded end is made to enable the instrument to be introduced into the bowel without causing any damage (*Fig.* 237) ; but even with this protection the tube must be employed with great care, as the bowel has been ruptured on more than one occasion.

When the instrument has been fairly introduced, the metal plug is withdrawn, and an eye-piece carrying a small lamp on a rod, and a nozzle for connection with the bellows, are fixed in position. By switching on the battery the lumen of the bowel opposite to the open end of the tube is illuminated and can be examined. If it is desired to push the instrument higher up, the gut is inflated by means of the

bellows, and as the result of this the valve-like folds of mucous membrane peculiar to the rectum are displaced, and the tube passes readily for a considerable distance (*Fig.* 238).

This examination may be conducted without any anæsthesia ; but if the patient is nervous, a general anæsthetic should be given.

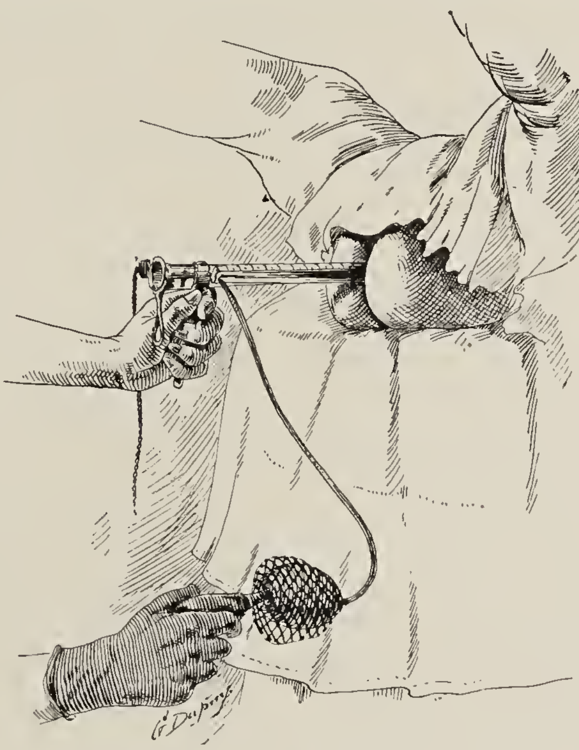


Fig. 238.—THE SIGMOIDOSCOPE IN USE.

The information gained by a thorough examination is very valuable, though a good deal of experience is necessary before the correct interpretation can be put on the picture that is seen.

CHAPTER XL

OF HÆMORRHOIDS AND VARIOUS MINOR OPERATIONS

OPERATIONS ON THE RECTUM AND ANUS.

MANY operations on the rectum and anus may be performed by the house surgeon. In all these cases the importance of careful preparation of the patient should be fully realized, as his future comfort as well as the success of the operation depend upon it. It is not sufficient to order a purge ; it must be seen that it acts thoroughly and that the bowel is well cleared out. Liquid paraffin (2 drachms three times a day) should be administered for a week before and after operation. If an operation is to take place on Monday, a full dose of castor oil should be given on Saturday night or early on Sunday morning. On Sunday evening the lower bowel is well washed out with a soap-and-water enema. On Monday morning, an hour before the time fixed for the operation, a suppository of morphia, gr. $\frac{1}{4}$, should be introduced, unless a spinal anæsthetic is given. No washing out should take place on the morning of operation.

Anæsthesia.—These operations are best performed under spinal anæsthesia unless it is contra-indicated. The value of this anæsthesia is that the sphincters are entirely relaxed and no stretching is necessary. This stretching is the cause of the post-operative pain. After operation under spinal anæsthesia a morphia suppository is never required, and many patients under my care have had their hæmorrhoids 'stolen' from them, the preliminary morphia-scopolamine narcosis being sufficient in many cases to abolish the memory of the visit to the operating theatre, and the absence of pain subsequently making them doubtful as to whether the operation had taken place

The hæmorrhoids are exposed by passing a dry swab into the anal canal and withdrawing it, when the hæmorrhoids come out on the swab and can be easily dealt with.

Dilatation of the Sphincters.—If a general anæsthetic is given, the two index fingers are introduced into the bowel, and gentle pressure is begun—outwards towards the ischiorectal fossa, and forwards and backwards towards the pubes and coccyx. After a little time the sphincters will begin to yield, when the thumbs may be substituted or the middle fingers inserted alongside the index. By gradual and progressive stretching, the muscles will be felt to give way, until the anus lies patulous before the operator and the rectal mucous membrane prolapses through the orifice.

As a rough guide, it may be said that the operator should spend about two minutes over this preliminary, and he should not be content

until all ' grip ' of the sphincters is lost. During the period of dilatation, the patient will be noticed to breathe deeply, and there is often some risk of an overdose of anæsthetic while the dilatation is proceeding. The anal region is now thoroughly washed with weak lysol.

Internal Piles, which are easily recognized as bluish tumours with a tendency to pedunculation, are seized with clamps or Spencer Wells's forceps and dragged down well into view. It is usually quite needless to remove more than four of these swellings, since the cicatrization which follows has the effect of causing any others present to shrink, and an extensive removal of mucous membrane is apt to be followed by a stricture—a very distressing complication.

The most obvious piles will be found in three situations : one anteriorly in the middle line, and one on each side ; occasionally a fourth, posteriorly, requires to be treated. The piles are pulled down, and the operator snips round their base with a pair of scissors, cutting through the mucous membrane as it passes from the bowel on to the pile, the object being, as it were, to shell out the tumour. As much mucous membrane as possible should be left ; and as this dissection is carried up towards the upper extremity of the pile, an attempt should be made to form a distinct pedicle in which the blood-vessels will run. It is usually quite easy in this manner to separate the swollen hæmorrhoidal vessels from the wall of the bowel, the vessels still retaining a partial covering of mucous membrane on their inner aspect.

The pedicle should now be ligatured with strong silk or thread, which should have been tested beforehand. The pedicle not only consists of a leash of hæmorrhoidal veins, but also contains a branch of the superior hæmorrhoidal artery, and unless the ligature be tied very tightly, it is liable to slip and allow bleeding to occur.

There are two reasons why the ligature is apt to slip : (1) In large hæmorrhoids the pedicle may be bulky and compressed with difficulty ; (2) The ligature is applied while some tension is being exerted on the pedicle. There is always a chance of a ligature slipping when the latter condition is present : for greater security the pedicle may be transfixed. When the ligature has been firmly tied, the bulk of the pile is cut off and the ligature cut down until the ends just protrude from the anus. This renders them easy of identification in case of any bleeding, and enables the surgeon to note exactly when they separate.

After this has been done, the parts are well washed with weak lysol and powdered with iodoform. A morphia suppository, gr. $\frac{1}{6}$, may be introduced, but is not required if the sphincters have been well dilated. External piles may be snipped away, and bleeding points ligatured if necessary. Very little need be done as a rule, and the less skin sacrificed the better. A pad of vaseline gauze or wool is placed over the anus and secured in position by means of a T bandage.

In simple cases it is not necessary to introduce any plugging into the bowel, but if there is great vascularity and a tendency to oozing after the ligatures have been tied, and especially if the tissues are soft and ulcerated, the following dressing may be employed with advantage. A rubber catheter, No. 16, is pushed into the bowel, and round it ribbon gauze thoroughly soaked with sterilized vaseline, or vaseline and iodoform, is packed. This packing should not be tight ; it should lie easily against the raw surfaces—its object being to assist nature in checking the hæmorrhage from the oozing surface. The catheter allows of the escape of flatus, which would otherwise be restrained by the packing, and also allows the surgeon to be quite certain that no concealed hæmorrhage is occurring.

Hæmorrhage after operations for piles is extremely disconcerting, because the bleeding points retract into the bowel and can only be reached with difficulty. When it occurs, an anæsthetic must be given, the sphincters again dilated, and an attempt made to secure the bleeding points. If this fails, the bowel must be plugged—an unsatisfactory and uncertain proceeding at the best. Rectal hæmorrhage may be exceedingly dangerous if the above precautions are not observed, owing to the blood being retained above the sphincters. In such cases the patient may bleed into his large intestine until he is blanched, before the complication is recognized.

Retention of urine often follows operations on the rectum, and a catheter may be required.

After-treatment.—The wound is dressed the next day. The plugging is removed—the vaseline coat allowing it to be withdrawn with very little pain. The patient lies on his left side, with the buttocks drawn well over the side of the bed. The buttocks, anal region, and perineum are well washed with a thick lather (soft soap and warm water), swabbed over with a dilute antiseptic, followed by spirit (the anal region being protected), and finally powdered and re-dressed. An excellent method of treatment is to keep the parts thoroughly soaked with lead and opium lotion ; this is a sedative and an astringent, and prevents pain and swelling. The bowels should be allowed to act on the fourth day, and up to this time the diet should consist of milk and slops.

In order to obtain a satisfactory and painless action, a pill or a dose of castor oil should be given over-night, and as soon as the patient feels a desire to go to stool, a cocaine suppository, gr. ½, should be introduced into the anus, followed in five to ten minutes by an injection of warm olive oil, 4 to 6 oz. Attention to these details will ensure an almost painless action. Sometimes a little bleeding occurs after the first action of the bowels, but it is rarely serious. The cocaine suppository should not be required after the first evacuation, but the motions must not be allowed to become hard and scybalous. Gentle laxatives—cascara or confection of senna—should be given every night. Each day the wound is to be washed and dressed, and after

the sixth day the house surgeon should introduce the forefinger into the bowel to make sure that no undue contraction is occurring ; this should be done every third day until the patient is discharged.

The ligatures should come away from the seventh to the tenth day, but the patient must not be allowed to get up until fourteen days have elapsed from the time of the operation, and then only if the parts are soundly healed. Neglect of this latter precaution is a constant source of failure.

There are many other excellent operations for the treatment of hæmorrhoids, but they will not be described here, as the object of this book is to describe in detail a simple and satisfactory procedure.

It will not be out of place to remind the reader that piles may be associated with malignant disease of the rectum, as well as with cardiac and hepatic disease.

Painful Fissure or Ulcer of the Anus.—Small but very painful cracks, or small ulcers, are often found at the margin of the anus, and although they are very insignificant in appearance, they may render life almost intolerable.

Treatment.—Lunar caustic, nitric acid, or a touch with the actual cautery will sometimes cure them, the treatment being combined with the use of astringent enemata ; but in severe cases there will be hardly any improvement unless, in addition to such application, the superficial fibres of the sphincters in the neighbourhood of the ulcer are set at rest.

This may often be done by inserting the thumbs within the anus, and suddenly stretching the part ; or a rectal dilator may be similarly employed.

But the most certain way to attain this rest is to incise the base of the fissure in its whole length, so as to divide the fibres of the sphincters which have, by their spasm and irritability, prevented the sore from healing. To do this effectually, an anæsthetic will be required, and a speculum is very necessary to ensure a complete view of the parts.

It often happens that these fissures are in connection with small piles, and occasionally with polypi. These must be removed at the time the fissure is incised.

Prolapsus Ani.—This condition is found in children and adults, but is more frequent and much less serious in the former. Infants are very often brought to the casualty room with the complaint that 'their body comes down' every time the bowels are opened. The patients will generally be weakly and ill-nourished, and on inquiry it will often be found that they have been allowed to crouch for as much as a quarter or, it may be, half-an-hour, upon a chamber utensil.

Treatment.—For the first few days the child should be kept in bed, the diet carefully regulated, and mild aperients given if there is constipation. The bowels should be allowed to act when the child

is lying on its side, and for some time the use of the chamber or 'chair' should be prohibited. The protruding anus, or rather the rectum, must be returned each time it comes down, and the opportunity may be taken to apply an astringent lotion (as 2 gr. of sulphate of iron to an ounce of water) to the part. The buttocks may be douched with cold water, anything like constipation should be avoided, and general tonics, as syrupus ferri phosphatis, given.

Under such general treatment, most cases of prolapsus in infants will very quickly get well ; but if the case be more severe it may be necessary to apply some kind of *Spring Truss*, made on the principle of those for uterine displacement, or a plug or pad, one pattern of which is shown in *Fig.* 239. The house surgeon must bear in mind that an intussusception has often been taken for a prolapsus ani, though careful examination will soon tell him what is the nature of the case he has to deal with.

When the prolapse is the result of worms or rectal polypi, the removal of these will usually effect a cure.

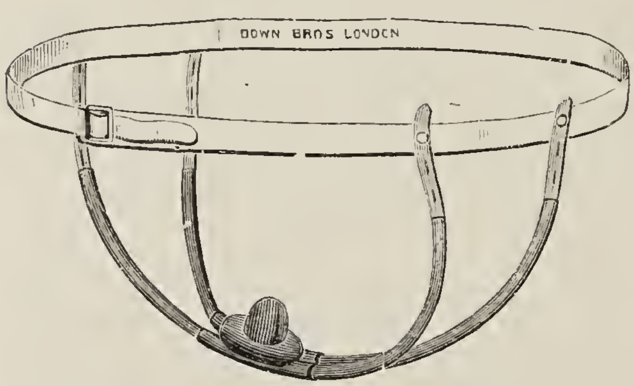


Fig. 239.
Truss with Pad for Prolapsus Ani.

If the above measures fail, the child should be anæsthetized, the sphincters dilated so as to give a sufficiently full view of the part, and the prolapsed bowel lightly cauterized with the actual cautery, the lines of the cautery following the natural longitudinal folds of the anal canal. It is not necessary to burn deeply into the tissues, for the object of the treatment is to excite sufficient inflammation in the mucous and submucous tissues to cause the former to shrink up and become more firmly adherent to the latter. A little sterilized vaseline is smeared over the part, and a pad of wool applied. This method is very satisfactory in relapsing cases.

Prolapse in Adults is a more serious affair, and it may require extensive operative treatment. Supposing the case does not yield to a patient replacement of the gut, with the application of astringent lotions, the surgeon may use a stronger caustic application, as the lunar caustic in the solid form or in strong solution, or nitric acid ; or he may score the mucous membrane over with the Paquelin cautery, taking care in each case that the caustic or cauterizing action be limited to the mucous tissues. The prolapse should then be returned, and the case treated in the same way as if it were one of internal piles.

In more severe cases still, portions of the prolapsed membrane may have to be removed with the ligature, or clamp and cautery, as in the case of piles.

Fistula in Ano.—We shall here consider only the less serious from of this affection, and will suppose that in all the cases with which we

have to do, the fistula is one which involves only the lower inch and a half or so of the rectum, and is thus well within the limits of safety as regards hæmorrhage. In most cases the fistulæ commence as ischiorectal or anal abscesses, more or less acute at first, and afterwards becoming chronic. On examination a small, often a very small,

Fig. 240.—Brodie's Fistula Probe.

aperture will be found, which on pressure will exude a little thin seropus ; and on probing, this will be found to lead along a small channel, tending in the direction of the rectum. Fistulæ are often tuberculous : such an origin may be suspected when the onset has been accompanied by little pain, and when there is an absence of induration round the fistulous track. The perineal region is often covered with long silky hair. If there is the slightest suspicion of the condition being tuberculous, a physician should be asked to examine the patient. Although operation is not always contra-indicated, special care and precautions must be taken.

Treatment.—The only efficient treatment for this condition is to lay the sinus open, so as to convert it into a trench opening along its whole length into the rectum, and by subsequent management to force it to heal up from the bottom.

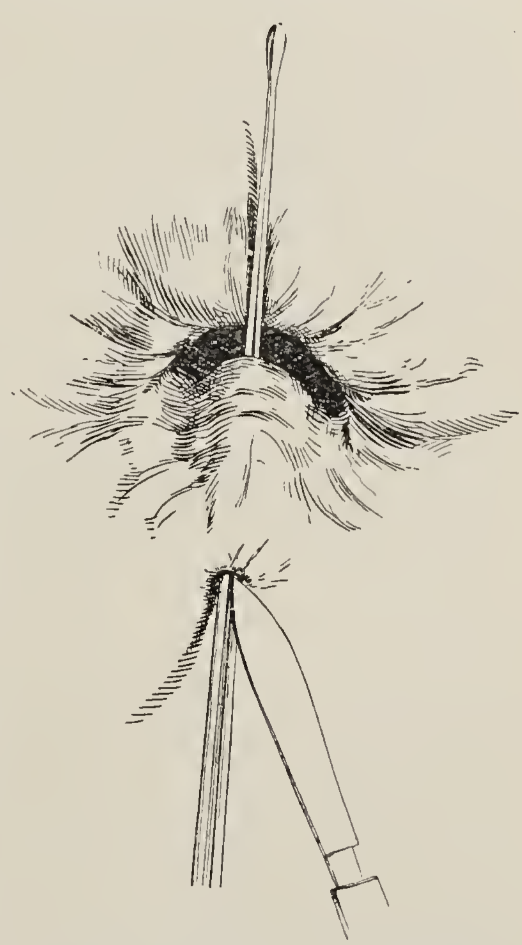


Fig. 241.—Illustration showing Division of the Track of a Fistula on a Director.

In all fistulæ the actual operation is much easier than the conscientious carrying out of the subsequent dressing. The readiest way to cut a fistula is to take a Brodie's fistula probe (*Fig.* 240), to pass it along the sinus, and, if possible, find the natural opening into the rectum ; if this is non-existent, or lies too high up, the end of the probe must be pushed through the rectal wall, wherever the sinus seems to come closest to the mucous surface.

As soon as the finger placed in the rectum feels the end of the probe, the instrument should be pushed on further and turned, so that its end comes out at the anus ; the sphincter and all the tissues between the sinus and the rectum must then be divided by a curved, sharp-pointed bistoury, special care being taken to divide the sphincter at right angles to the direction of its fibres, and not

obliquely. Most fistulæ have their internal opening between the external and the internal sphincter; in most cases the track runs superficial and not deep to the external sphincter muscle.

It sometimes happens, even in the simple fistulæ we are considering, that a probe passed along the sinus cannot be turned out of the rectum in this way ; if so, a director of the ordinary pattern should be passed along the track ; a curved probe-pointed bistoury should now be passed along its groove till the point is felt by the forefinger of the left hand placed in the rectum and against the end of the director. This finger must then be kept in contact with the end of the knife while both are withdrawn. In this way the tissues between the fistula and the gut will be divided as before (*Fig.* 241).

The sinus itself having been slit up, it is necessary to perform certain trimming details, in order to ensure a sound healing. Thus the

Fig. 242.—Scoop for Scraping Sinuses, etc.

bottom of the trench into which the sinus is now converted should be incised along its whole extent, and oftentimes it will be wise to scrape out the granulation tissue which lines it, with the scoop which is here figured (*Fig.* 242) ; the unhealthy margins also should be freely clipped off, the best instrument for doing this being the fistula scissors (*Fig.* 243).

When all this has been done, the wound must be carefully packed with narrow strips of gauze, and the whole secured with a T bandage. There is hardly ever any bleeding which moderate pressure will not arrest. An anæsthetic will be required. However thoroughly a fistula may have been operated upon, the ultimate success or failure lies absolutely in the hands of the dresser. If, through carelessness, he allows the channel to roof itself over, no good will have come of all the surgeon's efforts ; he must, therefore, most patiently plug the wound to the bottom, so that it granulates soundly. The occasional application of lunar caustic to the sides may be of considerable value. Complicated fistulæ are not considered.

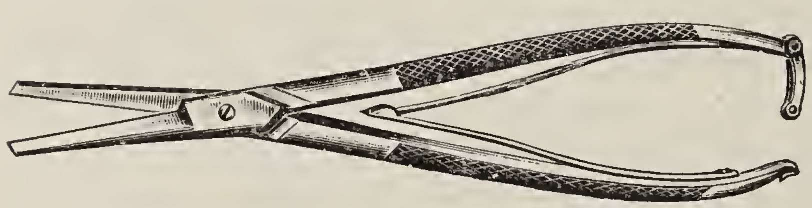


Fig. 243.—Scissors for Trimming Edges of Fistulæ, etc.

PHIMOSIS, PARAPHIMOSIS.

Circumcision for Phimosis in Children.—In the first place it may be stated that all children with a long foreskin will be placed in a better position, morally and physically, by being circumcised, whether

they have a true phimosis or no ; but these considerations apart, it is certain that many young children who have a certain amount of contraction of the aperture of the foreskin, but in whom the skin itself is not specially redundant, are subjected to circumcision quite unnecessarily. In a great number of these cases, all that is necessary is that the orifice should be dilated with a pair of dressing forceps, and the foreskin peeled off the glans penis, to which it is generally adherent. But if the amount of the foreskin be distinctly redundant, whether the orifice be contracted or not, a circumcision should be performed, and in children this is a simple operation. An anæsthetic having been given, the foreskin should be drawn well forward over the glans, and held between the jaws of a pair of dressing forceps, but not so tightly as to bruise the parts. A special instrument has been devised, but this is not necessary.

The redundant skin should then be cut away, and if the mucous surface be adherent to the glans it should be peeled off. There will now be an extensive ring of raw surface round the glans, between the edge of the mucous membrane and the edge of the skin, which has retracted. The next step is to cut through the mucous membrane down the dorsal middle line to the level of the skin margin, and then, after removing redundant portions of the membrane so that a little frill of rather more than a quarter of an inch is left at the coronal sulcus, to attach the skin and mucous edges round the organ by a few points of suture, catgut being the best to use.

There are not more than two arteries which ever seem to require tying, and they should be secured with fine catgut. The dressing wound should be perfectly light and simple ; a piece of lint soaked in lead lotion does as well as anything.

Circumcision and Slitting up the Prepuce in Adults.—This operation may be required, as it is in children, for congenital phimosis, and in such cases will not differ at all from that we have just described ; but it may also become necessary in consequence of an acquired contraction of the foreskin, and this again may be due to an inflammatory condition present at the time of operation, or to one which has ceased.

If a long foreskin be in a state of acute inflammatory œdema, it may be necessary to expose the glans penis for urination, or for the purpose of getting at sores. In such a case no planned circumcision is called for, nor would the results be satisfactory All that can or need be done is to pass a director under the foreskin in the middle line of the dorsum, and to cut the tissues along this with a scalpel or strong scissors down to the sulcus. The bleeding, up to a certain point, will be beneficial, but it can be easily stopped by pressure or by the ligature of any spouting vessel.

The phimosis which results from such an inflammation, but which has not required slitting up in its acute stage, may be operated on later in the more artistic method we considered first. This may sometimes be the best plan, but more often it will be found advisable

to divide the prepuce along the dorsum, and then to readjust the divided skin and mucosa in the most symmetrical way possible.

As soon as the operation is concluded, a piece of lint soaked in lead and opium lotion is loosely wrapped round the penis. This lotion is antiseptic, sedative, and astringent. Over the lint a piece of oiled silk or waterproof lies to keep the bedclothes from becoming soiled. The lint should be changed every two or three hours. In the case of adults, they can be taught how to clean their hands, soak the lint, and apply it themselves. When micturition is performed the lint is removed, and after the act, a fresh piece is applied. Painful erections have been much less frequent since this dressing has been used.

Paraphimosis.—In this condition the glans penis, with some of the everted mucous membrane of the foreskin, is strangulated by the narrowed aperture of the natural or acquired phimosis, through which it has protruded, but cannot be returned owing to the œdema.

In children, a natural phimosis is generally the cause ; in adults, as a rule, the case is one of balanitis with inflammatory effusion and contraction of the foreskin. In any case, the condition causes pain, and will steadily get worse until it is relieved.

Reduction.—In children, and in the less severe forms in adults, the foreskin can, as a rule, be drawn over the glans without much difficulty. The part having been first well oiled, the size of the œdematous glans can be reduced by wrapping a piece of lint round it and firmly grasping it in the hand for a minute or so, after which, by pressing it directly backwards with the thumb, at the same time drawing the foreskin forwards with the first and second fingers of both hands, the prepuce will come over. In more severe cases an ice-bag may be found useful, or the swollen tissue may be stabbed with a scalpel in several places, thus reducing the œdema.

Incision.—If these measures fail, the patient should be given an anæsthetic, and if reduction still cannot be effected, the constricting ring must be divided along the dorsum of the penis. This ring will probably be found to be very deeply imbedded in the swollen parts, so that care must be taken to identify the real seat of strangulation. If a paraphimosis be not reduced, the parts fall quickly into a sloughing condition, which will eventually relieve the constriction at the expense of deformity, through the loss of portions, or it may be of the whole, of the glans penis.

It will often be advisable to slit up the foreskin at the same time that the paraphimosis is relieved by incision, but this should be done after the reduction of the glans, as the natural condition of the part can then be more accurately seen.

VARICOSE VEINS

The 'ambulatory' treatment of varicose veins is widely practised. It consists in the injection into the vein of various substances which aim to cause a progressive sclerosis with eventual obliteration of the

PLATE VIII

INJECTION TREATMENT OF VARICOSE VEINS

A.—Position of the hands and needle for giving intravenous injections in simple cases.

B.—The direction of the needle and the position of the left forefinger for steadying the vein in some types of 'slippery' veins.

(By kind permission from Treves-Barber's 'Treatment of Varicose Veins.')

lumen of the vein. The injected substance destroys the intima, and an aseptic clot forms on the middle coat, organizing later into fibrous tissue. This affects not only the immediate site of the injection, but tends to spread peripherally, thus excluding many branches.

Drugs.—The drugs most often used are quinine hydrochloride (0·4 grm.) and urethane (0·2 grm.), sodium salicylate 20–40 per cent, sodium chloride 15–20 per cent, and glucose 66 per cent. The usual dose of the quinine compound is that given above; of the salicylate—according to strength—6 c.c. of 20 per cent or 4 c.c. of 40 per cent; the chloride 20 c.c. of 20 per cent; the glucose 5 c.c. of 66 per cent.

Contra-indications.—A careful preliminary examination of the patient is necessary, as there are certain conditions which contra-indicate the treatment—e.g., pelvic tumours, including pregnancy; cirrhosis of the liver; acute or subacute phlebitis; and cases following phlegmasia alba dolens, where the deep veins are probably defective. The presence of a varicose ulcer is not a contra-indieation; indeed many cases are treated for the cure of ulcer, but in these cases a strict antiseptic technique is essential.

Method of Injection.—The skin at and near the site of injection is prepared by swabbing over with iodine, which is then removed by wiping over with rectified spirit. The needle is inserted while the patient is standing, sitting, or lying (*Plate VIII*), but the injection should not be made while the patient is standing, as one aims at injecting the nearly empty vein. It may be necessary to insert the needle in the erect position in cases where the veins are difficult to identify when the patient is recumbent. It is rarely necessary to use a tourniquet to distend the vein, and it must be loosened before the injection is made so that the vein may be empty. The needle should be short-bevelled, and preferably have its eye laterally placed so as to bring the sclerosing fluid directly in contact with the intima (*Fig.* 244). It is most important to be sure that the needle is in the vein, and this is proved if blood flows from the needle after insertion. The syringe is then adjusted, and the injection made quickly or slowly according to the condition of the vein, stopping the injection during inspiration and injecting during expiration. To make sure that the needle is in the vein during the whole injection, a small quantity of blood should be aspirated into the syringe at least once, and if no blood comes the injection should be stopped. After finishing the injection, wait a full minute or more before withdrawing the needle, then withdraw it quickly and apply pressure over the puncture. The puncture should be sealed with collodion, and the patient kept quiet for ten or fifteen minutes. It makes for comfort to apply a dressing of glycerin and zinc oxide with mucilage of gum acacia.

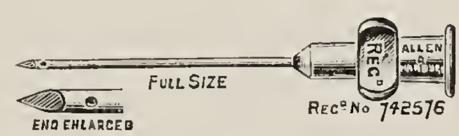


Fig. 244.—Treves-Barber's needle for injecting varicose veins.

(*By kind permission, from Treves-Barber's 'Treatment of Varicose Veins.'*)

CORNS, WARTS, AND CONDYLOMATA.

The common **Corn** which forms about the foot deserves perhaps more notice than it generally gets, for it often occasions much suffering, and may even effect complete disablement.

These growths, like other forms of papillomata, may be removed with the knife, but this operation, small as it seems, should not be very lightly undertaken, for even small corns dip deeply into the subjacent tissues, and will certainly recur unless they are completely removed, while all cuts about the foot refuse to heal kindly, so that the patient may be laid up for a good while. Professional corn-cutters as a rule confine their efforts to diminishing the amount of direct pressure upon the sensitive papillæ, by judicious paring of the horny layers ; but when they do attempt to remove the whole growth, they commonly effect it by setting up a little suppuration about or beneath its base. In other cases, a caustic, nitric acid being the best, is applied time after time ; the burnt parts being pared away.

But in the great majority of cases, palliative measures in the way of relief of pressure by properly cut corn plasters will effectually prevent pain without laying up the patient for an hour, and in the end will generally cure the corn.

'Corn plasters' as sold are too small, and are of the wrong shape. They should be cut to a pattern out of isinglass felt, or some similar adhesive material, and should be of a U shape, open towards the ankle, to allow of free circulation. The sides of the U should be at least thrice the width of the central space, which should just admit the corn. The plasters can be taken off at night and put on again in the morning.

Warts upon the hands are common in children, and in those who have to handle animal tissues (post-mortem-room men, and the like). In children they commonly disappear, vanishing sooner or later without being noticed. The best way to remove them is to touch them repeatedly with nitric acid and pare them away.

Both corns and warts may be made to disappear by the use of the following preparation of collodion, which is painted on daily : Salicylic acid 60 gr., extract of cannabis indica 8 gr., flexile collodion ($\frac{3}{4}$ strength) 1 ounce. After a time the skin that is formed is pulled off, leaving the corn substance soft and easily removable. The painting is continued till the corn has quite gone. The only objection to this method is its slowness, which sometimes prevents perseverance.

Urethral Caruncles occur about the aperture of the female urethra, and are exquisitely tender. It is generally necessary to give an anæsthetic before removing them, which is best done with the actual cautery, or with scissors, afterwards applying the cautery to their bases, to arrest the bleeding ; or the application of a 4 per cent solution of cocaine will allow them to be snipped off and the cautery to be applied quite painlessly.

Warty Growths of Venereal Origin are common about both the male and female genitals. They may generally be snipped off with scissors, and their bases touched with lunar caustic or nitric acid ; but sometimes they are so large that it is safer to ligature them, when the method detailed for piles may be followed. In other cases, when they are more sessile, the application of nitric acid will be best.

True Condylomata, *moist cutaneous tubercles,* are sometimes treated locally with the stronger caustics ; but more frequently powders which are somewhat escharotic, but which also serve to keep the parts dry, are preferred. Thus, equal parts of calomel and zinc oxide, or of subacetate and savin, may be used. Condylomata also yield to constitutional treatment much more readily than warty growths.

OTHER MINOR OPERATIONS.

Fistulous Tracts in the Groin and Elsewhere.—Sinuses in the groin are very common as the result of buboes, and once formed will burrow to an almost unlimited extent. But wherever the sinus may be, the same line of treatment must be adopted as has been before described for *fistula in ano.* Advantage may arise from an occasional application of lunar caustic to the edges and base of the trenches. It is hopeless to expect any healing until the tunnel has been converted into a trench, and made to heal from the bottom. The windings of the fistulæ must be followed up with the director and scalpel, and the details of scraping, trimming, and dressing are precisely as before described.

Ingrowing Toe-nail and Avulsion of Nails.—The great toe-nail often produces an extremely painful ulceration, on one or both sides, by an ingrowth of its margins. The irritation thus produced causes a hypertrophy of the neighbouring skin, and a condition of paronychia, so that the nail may come to be half buried in fungous granulations, with a fœtid discharge, and the patient may be unable to put his foot to the ground. There are probably very few, if any, cases of ingrowing toe-nail which *cannot* be cured by measures short of pulling out the nail, but in all except the slighter forms, much time and patience will be required to achieve success.

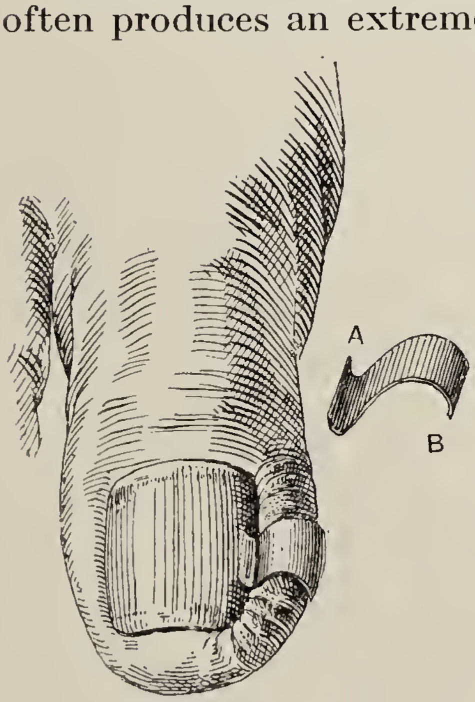


Fig. 245.—Silver Lever for Ingrowing Toe-nails.

If the nail is to be kept, the common treatment is to lift it up gradually from its bed, by gently packing something, such as a pledget of cotton-wool, beneath its edge, once or twice a day ; and at the same time to reduce its thickness to that of a piece of note-paper by rubbing it down, for which purpose pumice stone will be most serviceable.

The exuberant edges may be touched with caustic ; and iodoform, or the powder of the nitrate of lead, will be found a good application to the ulceration. A solution of caustic soda 1–40 will soften a nail so that it can be dealt with more readily.

The use of a small piece of sheet lead slipped beneath the nail to raise its edge has long been known, and either that or a piece of silver, about the thickness of note-paper, and about $\frac{1}{2}$-in. long and $\frac{1}{4}$-in. broad, is bent to the shape of A B in *Fig.* 245 (this can very conveniently be made out of a threepenny piece filed down), one end, A, being bent to a right angle. This end is inserted underneath the nail so that the ingrown edge just rests in the groove thus formed. The rest of the plate must then be used as a lever, and pressed down upon the side of the toe until it lies against it as shown in the illustration. By this means the edge of the nail is raised, and the exuberant granulation tissue, which is almost always present, pressed down, and away from it. The plate is then fixed in position by a circular turn of strapping, cut about an inch wide (not shown in the figure).

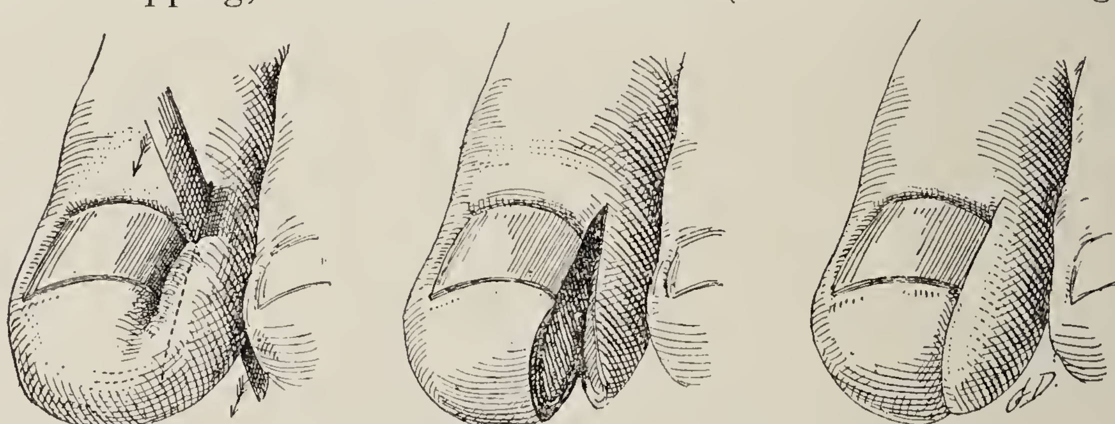


Fig. 246.—Operation for Ingrowing Toe-nail.

The relief afforded by this simple adjustment is immediate and very striking, so that patients can walk with ease as soon as the plate is fixed, and a permanent cure is generally speedy.

Working on these lines, as we have said, almost all ingrowing nails can be cured, and the patient can himself assist the process greatly ; but it takes time, and it may be readier and more satisfactory to remove the nail.

If the patient is willing to undergo an operation, the method advised by Watson Cheyne should be adopted. It is infinitely superior to avulsion of the nail. Under anæsthesia, an incision is made along the nail fold right down to the matrix ; in this way a flap is formed of the soft parts that lie alongside the ingrowing nail. Rather less than half the nail and the ulcerated tissue are then cut away, care being taken to see that the cut extends well down to the matrix and that the nail-bed is thoroughly destroyed. If this precaution is not taken, the operation will be a failure. The flap is now readjusted so that it lies on a lower level than the nail, and it is secured with one or two sutures. This is a radical and very satisfactory method, and one which will completely cure the trouble (*Fig.* 246).

Other nails, both of fingers and toes, may require removal for onychia, abscess of matrix, injury, etc., but in such cases it will generally be best, in preference to splitting the nail and wrenching it off, to separate the nail gently from its bed, until it can easily be pulled away ; this is especially the case in removal of a finger nail, where great care is required lest the matrix itself should be scarred ; the results will not show at the time, but as the new nail grows, the cicatrix in the matrix will cause the nail to be permanently misshapen.

Warty Growths from beneath the Nails, and especially from beneath the great-toe-nails, are not infrequent. They will, if neglected, cause pain and ulceration by pressure, and it is always best to remove them. This may generally be done by paring, and the use of some caustic ; but it may be necessary to remove a portion or the whole of the nail in order to get at the base of the growth.

A Small Cancellous Exostosis is also apt to form beneath the nail of the great toe, and this is often mistaken for a warty growth, but its nature will be recognized by careful examination. It should be removed early, for if allowed to grow it will be sure to occasion inconvenience. The best method of getting it away is to pass a scalpel round its base, cutting all the tissues down to the bone, and then to snip it off with small sharp bone forceps. As in the case of warts, it may be necessary to remove a part or all of the nail to expose it.

Tongue-tie.—Mothers very frequently bring their infants to the hospital in the belief that they are tongue-tied, when either there is nothing the matter with them, or else there is only a fragile band of membrane which can easily be broken down with the finger. But if the frænum linguæ be really too short and thick, it must be divided with a pair of blunt-pointed scissors, the points of which must turn downwards, towards the floor of the mouth. The tongue must be held up by two fingers, or by that special form of spatula with a slit in it, combined with a director, which may often be found in pocket instrument cases.

Vaginal Adhesions.—Very commonly indeed, newly-born female children are brought with the report that 'the womb is shut,' or some similar phrase is used : when, upon examination, a small pin-hole aperture is seen, by which the urine escapes, and at first sight the rest of the vaginal opening seems to be absent. But if a probe or director be passed into this opening, and pressed downwards, it will be seen that the parts are perfectly normal, and that there has been only an adhesion of the margins of the vaginal orifice.

No further treatment is required, and we mention the condition only because it is so often mistaken by mothers and dressers for something far more serious, whereby much anxiety is caused.

Nævi.—We will here consider *cutaneous* or *capillary nævi* (mother's marks), and the smaller subcutaneous ones. With regard to both, but especially the former, one fact is often forgotten, indeed seems hardly to be generally known, namely, that *if left alone they will very*

frequently disappear. To show this, let the reader consider how very rarely the affection is met with in adults as compared with the number of children who are brought to the O.P. rooms for treatment.

It is, therefore, in infants, a good general rule to postpone treatment for a month or two at least, after they are first seen, unless the stain be rapidly growing, or be in a very disfiguring situation.

The only way of treating *superficial nævi* is to destroy them with some form of caustic or cautery. *Carbon-dioxide snow* is now used almost exclusively for the treatment of superficial nævi, and gives admirable results. *Radium* may also be employed.

Any form of actual cautery may be successfully used, Paquelin's perhaps being the most convenient. The whole depth of the skin must be destroyed, and the parts dressed in some simple fashion while the sloughs separate.

In situations such as the face, where complete destruction of a large superficial nævus would leave a disfiguring scar, good may occasionally be done by slight superficial applications of the cautery, frequently repeated, a small portion of the nævus being done at one time. If successful, a thin white scar will ultimately be formed, but the treatment is long and tedious.

Subcutaneous Nævi may be treated upon two principles : that is to say, measures may be taken which will produce sloughing out of the entire mass, or which will merely produce a consolidation and stasis of the blood-current through it, which consolidation is later followed by a gradual absorption

By Ligature.—For the ligature of a subcutaneous nævus of ordinary size, the readiest way is to take a needle, double threaded with stout silk or whipcord, and with it to transfix the base of the growth. The needle having been cut off, there will be left two cords running below the tumour, and these may if necessary be increased to four or six by repeating the process of transfixion. The cut ends of these ligatures have now to be knotted together very tightly, each to each, and before this is done it will almost always be advisable to cut the skin in the form of a ring at the base of the growth. The nævus will then be completely strangulated, and must be left to slough off. During its separation it may be dressed with any simple antiseptic dressing.

Sometimes elastic ligatures, or such as can be tightened up from time to time, are used ; in any case the cords must be tied very tight.

The means adopted for securing consolidation of nævoid growths are numerous, but we mention only one or two of the principal ones.

Electrolysis, or the passage of a constant current, finds an application here, its object being to produce stasis and coagulation in the blood-vessels, but not sloughing of the tissues. The current should be just strong enough to decompose water ; and the needles must be insulated with the exception of about $\frac{1}{4}$ in. at the end, to prevent the current from acting on the skin and causing sloughing. One needle is connected with each pole of the battery and inserted into the tumour, care being

taken that the non-insulated portion is buried in the nævus. The current is passed until the swelling becomes white and hard ; it must then be reversed for a short time to prevent hæmorrhage. If the nævus be deeply seated, the effect will have to be estimated by the hardening of the tumour. The operation frequently has to be repeated, and it is often advisable to use more than two needles, especially if the nævus be large (*Fig.* 247).

The Actual Cautery may also be used, multiple punctures being made into the nævus. Cure takes place by a mixture of sloughing and consolidation.

Small subcutaneous nævi which are distinctly encapsuled may often be dissected out, and although the operator must carefully

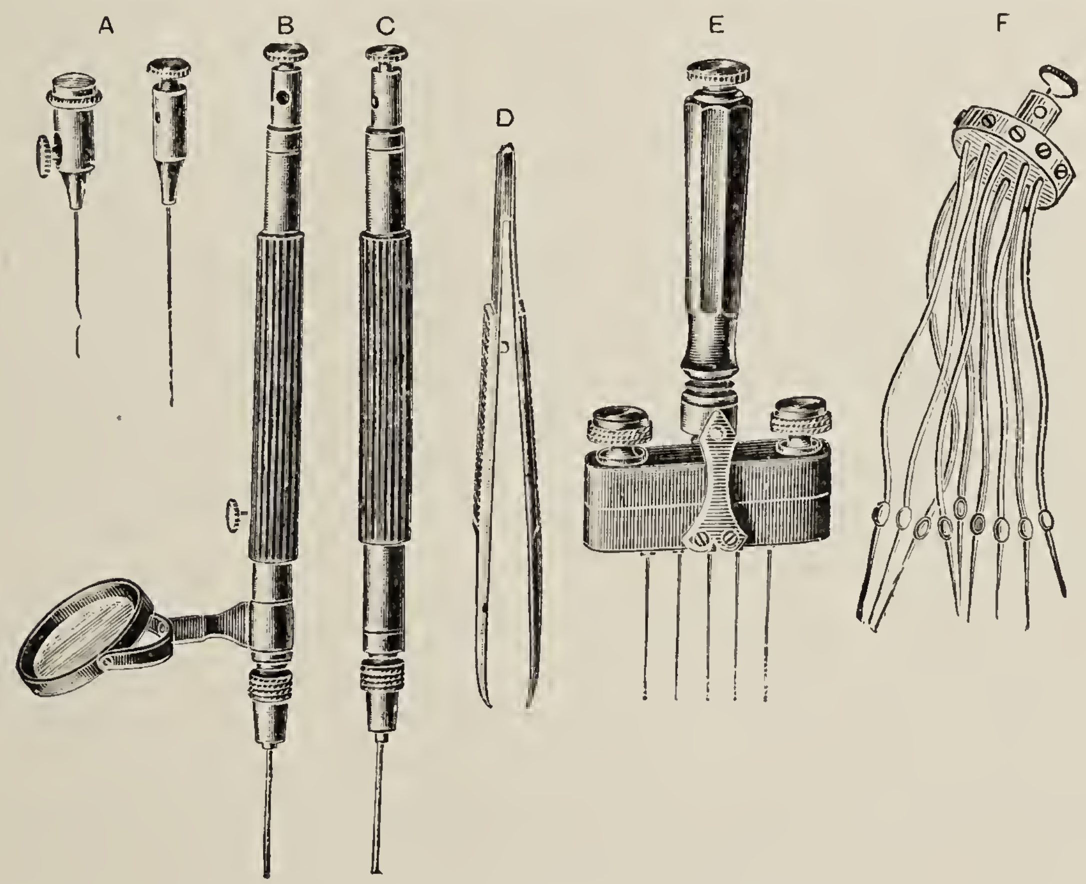


Fig. 247.—Various Needles, etc., for Electrolysis.

A, Needles with terminal. B, Needle-holder with magnifier attached. D, Forceps for depilation. E, Multiple needle-holder for nævi. F, Electrode for the destruction of tumours.

avoid cutting into the small tumour while it is being removed, it is a very satisfactory treatment, though not generally applicable. All bleeding ceases as soon as the nævus is taken away.

The Galvano-cautery may also be used in the treatment of nævi, when they are large and when a less conspicuous scar is required, as on the face or neck.

A small puncture is made into the nævus with a tenotome, and the cautery wire inserted into the growth ; the current is then turned on, with the result that the nævus is burned 'subcutaneously.' The point may be moved about in various directions to destroy different parts of the tumour, and if care is taken very little of the skin will slough. Vaseline should be smeared over the puncture.

SECTION VIII

OF SPECIAL CASES CONNECTED WITH THE HEAD AND THROAT.

CHAPTER XLI

MINOR SURGERY OF THE EYE

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IN this chapter we have restricted ourselves to those subjects with which a house surgeon in a general hospital may have to deal on his own responsibility. We have given only a brief clinical description of them, but in the matter of treatment we have gone into some detail, since even in such a simple operation as excision of the eye it is the careful attention to small details which makes the difference between the rapid operation of the skilful, and the slow bungling of the inexpert.

AFFECTIONS OF THE EYELID.

Wounds of the Eyelid.—Wounds of the eyelid, when they do not involve the lid margin, usually heal very readily. They should be carefully cleansed, and the finest silkworm gut used for stitches. When the lid margin is involved, and especially if the wound is at all a ragged one, it must always be borne in mind that restoration of a neat margin is the most important thing to aim at, and that the marginal stitch should therefore be inserted first. In doing this, care should be taken to see that there is no inversion of the skin on either side, as this may result in an ingrowing eyelash, which, rubbing on the cornea, would give rise to constant irritation.

Inflammations of the Lid Margins.—Inflammation in the hair follicles and in the sebaceous and sweat glands which open into the hair follicles is a very common disease in children (ciliary blepharitis). The inflammatory exudates form little crusts which lie along the roots of the lashes, blocking the mouths of the hair follicles, and in old-standing cases causing erosion and pitting of the skin round the hair roots. An error of refraction is in most cases the main predisposing cause. In treating this condition, it is to be borne in mind that the real seat of the disease is in the depths of the hair follicles, and not on the surface, and that before any application can

reach this point, as much as possible of the surface exudate must be dissolved. In slighter cases it usually suffices to bathe with a warm alkaline lotion until all the crusts have been dissolved, and to rub in a very dilute ointment of nitrate of mercury (1–10 B.P. strength). In more severe cases it is advisable to pull out the lashes in the most affected part, to clip off the others, and then, after bathing thoroughly, to touch the whole of the row of hair follicles with mitigated silver stick (1 part of silver nitrate, 4 parts of potash nitrate, fused together). Another excellent method is to substitute for the mitigated stick thorough scrubbing with 25 per cent protargol. In older people a similar condition is often produced by the organism which causes chronic angular conjunctivitis (diplobacillus of Morax). For this type of inflammation, a lotion containing $\frac{1}{2}$ per cent zinc sulphate, and a cream made up of zinc oxide, lanolin, and olive oil, are best.

℞	Zinci Oxidi	gr. x	Olei Olivæ	ʒij
	Liq. Calcis	♏x	Lanolini	ad ℥j

Hordeolum (or Stye).—This is an acute inflammation of the hair follicle and glands leading into it. It usually commences by a puffy swelling of the lids, more or less localized, which later comes to a head. Early fomentation will sometimes bring about resolution. As soon as the little abscess points, it should be pricked and 'hotbathed'. Hot bathing is performed by the patient himself in the following manner. A teaspoonful of boric acid crystals is put into a bowl and a pint of nearly boiling water is added. He is given a wooden spoon with cotton-wool wound round the lower end, and he dips the latter into the hot lotion and then holds it up against his closed eye. The saturated cotton-wool should be as hot as the patient can bear, and as soon as it cools he should dip it in again, continuing the process for a quarter of an hour. At the end of this period a pad of warm cotton-wool is applied to the eye and kept in place with a bandage. If necessary the procedure may be repeated three times daily. As most of these cases are due to staphylococcal infections, stannoxyl (a mixture of pure powdered tin and oxide of tin) given internally has a very beneficial effect.

Epilation.—It occasionally happens, especially in cases of old-standing trachoma, that some of the eyelashes, instead of growing out, become inverted, so that they rub on the cornea or conjunctiva and keep up a constant irritation. The condition is known as trichiasis.

Fig. 248.—Flat-pointed Epilation Forceps.

The removal of these eyelashes is best performed with special flat-pointed epilation forceps (*Fig.* 248). No jerking is required, a firm, gentle pull bringing the hairs away easily and with little pain. Unfortunately the hairs usually grow again after an interval of from

six weeks to three months. If they are few in number, they may be killed by electrolysis; but when the trichiasis is marked, or associated with any degree of entropion, special operative methods are required.

Meibomian Cysts (Tarsal Cyst, Chalazion).—The Meibomian glands lie partly imbedded in the back of the tarsal plate, and can in many cases be seen as a row of paler lines shining through the conjunctiva of the everted lid. The openings of these on the inner border of the lid margin can be made out as a row of tiny dots. A chalazion is not a true retention cyst, but an accumulation of degeneration products, the seat of the change, whatever its nature, being as much in the tissue surrounding the gland as in the gland itself. It forms a small swelling in the lid, usually visible or at least palpable from the skin surface. Secondary invasion with pus cocci sometimes supervenes, and subsequent to that, granulating masses may protrude through the conjunctival surface of the lid. Often a cyst or cysts last for many months without producing pain or any other symptom beyond the deformity of the lid.

The treatment consists of incision and free curetting. With proper precautions, the little operation may be practically painless. Evert the lid and apply one or two crystals of solid cocaine over the conjunctival surface of the swelling. Leave it to act for two minutes, then with a fine-needled hypodermic syringe inject *into the cyst* about 5 min. of 2 per cent cocaine in 1–2000 adrenalin. Let this again act for two minutes. With a Beer's knife (*Fig.* 249) make a vertical incision through the conjunctival wall, and then thoroughly scrape away with a small curette all the gelatinous and diseased tissue from the walls of the cyst. It is best to apply a pad and bandage for twenty-four hours, and to have the eye bathed frequently with boric-acid lotion for some days. Occasionally it may seem that a portion of the cyst has been left. This is due either to the space filling up with blood which takes some time to absorb, or to slight post-operative inflammation. The swelling usually disappears completely in a couple of weeks. In some patients a constant succession of these small cysts appear at intervals of a few months. In such cases the administration of stannoxyl or one of the manganese preparations may suffice to prevent recurrences.

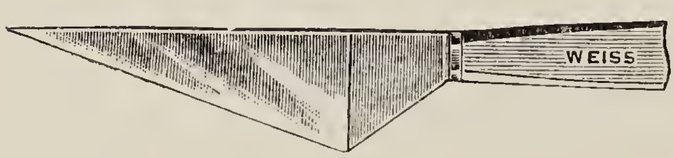


Fig. 249.—Beer's Knife.

AFFECTIONS OF THE CONJUNCTIVA.

Injuries to the Conjunctiva, when uncomplicated with injuries to other structures, usually heal up very readily. Small tears are best left alone. Even extensive tears seldom require more than one stitch. In some people, especially in old age, a very slight blow may result in a subconjunctival hæmorrhage of some extent. (A similar result is caused sometimes by a violent fit of coughing or vomiting.) Though

this looks very alarming to the patient, it is of no local consequence, and beyond the prescription of hot boric-acid bathing usually requires no treatment. When subconjunctival hæmorrhages occur frequently in a seemingly healthy person, it is advisable to have a careful blood examination made. The condition may be due to some deficiency in blood-coagulating power, and may be associated with a liability to attacks of urticaria. If it is of importance for cosmetic reasons to produce rapid absorption of the blood, dionin drops (5 per cent) may be used twice a day. In this case the patient should be warned beforehand that the drops may produce considerable swelling of the conjunctiva (chemosis).

Foreign bodies, such as bits of grit, coal-dust, emery, etc., frequently get into the eye. If not at once washed away by the flow of tears which the irritation of their presence causes, they usually obtain a lodgement under the upper eyelid and become embedded in the conjunctiva there. To find them it is necessary to evert the upper eyelid. They should be removed with a small piece of moist lint.

To Evert the Upper Eyelid.—The examination of the lower conjunctival fornix is simple. The patient looks up, the lower lid is pulled downwards, and gentle pressure backwards will then reveal it in its whole extent. To get a similarly good view of the upper fornix requires the knowledge of a little manœuvre very readily acquired and yet very frequently bungled. The method I adopt requires the use of only one hand, leaving the other free for any purpose, such as painting the lids. First of all persuade the patient to look steadily downwards at the floor or at his own hands, with the head thrown slightly backwards ; then place the ulnar border of the index finger on the upper lid immediately above the margin of the tarsal plate ; the thumb is placed on the lower lid, pressing it gently back. The index finger then gently presses the margin of the eyelid down on to the thumb, and by a slight movement the thumb completes the eversion. Straight pressure backwards on the eyeball will then bring the folds of the upper fornix into view. Standing in front of the patient, use the right hand for the left eye, and vice versa.

Acute Conjunctivitis.—The great majority of cases of acute conjunctivitis are caused by one of three organisms, the bacillus of Weeks, the pneumococcus, or the gonococcus. The first two organisms are the main causes of acute mucopurulent conjunctivitis. The gonococcus is the principal, though not the only, cause of ophthalmia neonatorum and of the acute purulent ophthalmia (blennorrhœa) of the adult. A rarer form of acute conjunctivitis, for which, however, the house surgeon must be on the outlook, is due to the diphtheria bacillus. Like the other forms of diphtheritic inflammation, it is characterized by true necrotic membrane formation and by grave constitutional disturbance.

In acute conjunctivitis due to the bacillus of Weeks or the pneumococcus, the clinical picture is simple. The eye first affected commences

to burn and smart, and becomes slightly photophobic. The margins of the lids become slightly red and puffy. This puffiness seems usually more marked in the lower margin of the upper lid. The palpebral conjunctiva becomes greatly congested, very red, and swollen, but usually retains a smooth surface. Only very rarely does one see any follicular enlargement in the fornices. The bulbar conjunctiva becomes of a uniform red colour. Later on, especially in adults, this becomes flecked with tiny ecchymotic patches disturbing the uniformity of the pink. The bulbar conjunetiva usually shows only slight swelling or chemosis. Sometimes tiny swellings resembling phlyctenulæ develop at the corneal margin. In tuberculous children true phlyctenulæ may develop. In the height of the inflammation there is usually a good deal of purulent secretion along the lid margins and in the angles of the eyes, and little flakes of pus float in the conjunctival sacs. The two eyes are usually affected within a few days. The inflammation runs its course in from one to four weeks. Sometimes if untreated it tends to leave a chronic inflammation, in which there is follicular enlargement. The pneumococcal conjunctivitis is self-limited, especially when it occurs in epidemic form. It is not so infectious as the form due to the bacillus of Weeks. In epidemics it is mostly children that are infected. In severe forms it sometimes gives rise to membrane formation, but this is never a true necrotic membrane. There is probably a greater tendency to the formation of phlycten-like swellings at the limbus of the cornea, and in my experience a greater tendency to tiny ecchymoses. The essential difference is in the course of the disease, which is self-limited, reaching its climax in five or six days, and then resolving rapidly.

Fortunately, when we come to the question of treatment there is no need to differentiate between the two forms. The main essentials are efficient and regular cleansing with some simple aseptic lotion, the destruction of the organisms and their removal along with the affected tissues, and the replacing of the latter by healthy tissue. In the use of a lotion the most important effect is the mechanical cleansing and irrigation. For this purpose the lotion should produce as little irritation as possible, and should be used as warm as it can be with comfort, and in no niggardly fashion. A weak boric acid lotion in most cases fulfils these requisites, but where it produces irritation, as it sometimes does, it is best to substitute normal saline. The comfort produced by the free use of lotions is probably almost entirely due to the freeing of the conjunctival sac from portions of desquamated epithelium and flakes of pus, which act as irritants like any other foreign body. In mild cases this cleansing of the eye and the prescription of a simple ointment to prevent gumming of the lids is really all the treatment required. In more acute cases, nothing can replace the salts of silver in efficacy, and for certainty and efficiency silver nitrate is still the best, and properly used is likely to retain its position.

We are dealing now with organisms whose action is not only on the surface. To rid the eye of such we have to employ some agent which will be able to attack them where they are most active. When we brush the eyelids with silver nitrate in a 1 per cent or 2 per cent solution, what we first notice is, that a faint bluish-white pellicle forms on the conjunctiva. This is due to the coagulation of the proteins of the cells by their conversion into albuminates of silver. This conversion means, of course, the setting free of a certain amount of free nitric acid, with the consequent great irritation which invariably follows painting with silver nitrate. In other words, the silver nitrate produces a coagulation necrosis in the surface cells. The conjunctiva immediately sets itself to get rid of this surface slough, and for the next two or three hours there is an increase in the amount of secretion from the eyes, and the eyes seem to feel even more gritty than before. The contained organisms are acted on at the same time as the cells, and are thrown off with the cells, and though some undoubtedly remain, the number has at least temporarily been greatly diminished, and the supply of toxins is diminished proportionately, with the result that the irritation caused by the toxins is very greatly relieved, and within an hour or two of the painting, the eyes feel cooler and more comfortable than at any time since the inflammation commenced.

In using silver nitrate we must be fully cognizant of the results we wish to produce. As it is only the superficial layers which are affected, it would be unwise to employ the silver nitrate in such strength as to affect the deeper-lying tissues where there are no organisms, and it would be equally unwise to re-apply it before the lapse of an interval long enough to allow of a complete regeneration of new epithelium to replace that thrown off. The most serious damage in using it too strong or too frequently is that, by doing so, deep sloughs may be formed, which when thrown off may leave raw surfaces in apposition, and so give rise to adhesions which may become permanent. Such a result is not uncommon from over-anxiety on the part of those in charge of a serious case. As a general rule, I should recommend that an interval of at least twenty-four hours be allowed to elapse between any two successive applications of silver nitrate even in severe cases, and any excess should be always removed or neutralized by salt solution at the time of application.

The great irritation caused by the use of silver nitrate has led to numerous attempts to replace the violently irritant inorganic acid by some non-irritant organic acid. Many of these preparations exist, such as protargol, collargol, and argyrol. My personal preference is distinctly in favour of argyrol, used in strengths varying from 10 to 25 per cent, and it is in this form that I always prescribe silver salts when I give them to patients for home use.

Acute Purulent Conjunctivitis (Blennorrhœa).—Ophthalmia neonatorum usually commences on the third to the fifth day after birth.

It is characterized by a profuse, thin, purulent secretion. There is usually some chemosis, but very seldom the intense œdema of the conjunctiva which forms such a marked and serious feature of gonorrhœal conjunctivitis in the adult. Cases of ophthalmia neonatorum must be seen daily by the house surgeon. After washing away the secretion and examining the cornea, the conjunctival fornices are brushed out with a weak silver nitrate solution (1 per cent). The best method of examining a young child's eye is to sit opposite the nurse, who holds the child's body and hands close down to its sides, the head being grasped in a towel between the surgeon's knees. After carefully washing away all secretion, the cornea is examined. If necessary, the lids must be retracted with small bent-wire retractors. Sometimes even with retractors it is difficult to get a view of the cornea, as it tends to roll upwards in the effort to shut the eyes. By gently increasing the pressure of the lower retractor downwards and backwards, and pulling on the upper retractor, a view can usually be obtained. It is imperative not to use ill-applied force in these cases, as there is always a danger of causing a perforation in a badly affected cornea. If the cornea is not affected, a lotion of perchloride of mercury (1–6000) is prescribed to be used freely and frequently. The nurse or mother should be instructed that the lotion must get inside the lids, and that all the secretion must be washed away at each bathing. The intervals between bathing should not be longer than two hours.

If the cornea is affected it is advisable to substitute a weak boric acid lotion for the mercuric lotion, and to put in after each daily painting a small piece of atropine ointment (1 per cent).

The eyes should never on any account be bandaged or covered up. The secretion must be allowed a free escape.

In examining or treating any case of purulent ophthalmia, both nurse and house surgeon should wear goggles and rubber gloves.

Gonorrhœal Conjunctivitis in the Adult is mostly associated with urethritis, and is due to direct infection. Forms of purulent conjunctivitis due to other organisms occur, but are much rarer. The inflammation is of a most acute type, with very intense œdema and swelling of the eyelids and conjunctiva. It most frequently commences in the right eye in right-handed people, and one of the first duties of the house surgeon is to take measures to prevent the healthy eye being affected. To effect this, the inflamed eye should be covered with a pad soaked in some antiseptic lotion (1–2000 perchloride of mercury). The skin and lids of the healthy eye should be cleaned and scrubbed gently with lotion of the same strength, and the eye itself irrigated with a mild boric acid lotion. A Buller's shield (*Fig.* 250) should then be applied and carefully fastened down all round,

Fig. 250.—Buller's Shield.

except for a space at the outer part of the orbit, which is left for ventilation.

To make a Buller's shield, take an ordinary watch-glass—the glass of the patient's own watch will do if nothing else is available—and two squares of rubber adhesive plaster, one 4 in. square, the other nearly 5 in. Cut out of the centre of each a circle 1 in. in diameter. Fasten the larger square to the convex side of the glass and the smaller to the concave side, and the shield is complete, with about $\frac{1}{2}$ in. of adhesive plaster projecting to fasten it to the skin. The fitting to the nose and the brow must be very carefully done, so as to leave no gaps.

Having secured the healthy eye against infection, the affected eye can next be dealt with. The lid œdema and congestion may be so great that no view can be obtained of the cornea, and only chemotic (œdematous) conjunctiva can be seen projecting through the inflamed lid margins. In such a case there must be no hesitation in slitting up the outer canthus with a stout pair of scissors. This, with one or two free incisions into the œdematous conjunctiva, will do much to lessen the congestion, which if unrelieved may actually give rise to sloughing of the cornea through strangulation. Frequently changed fomentations, with free irrigation of the eye at each change, must then be ordered, and at the same time a free purging with calomel, followed by a saline aperient. If the pain is very great, sometimes more relief is obtained by using iced compresses and iced lotions for bathing. The lotion used should not be stronger than 1–10,000 perchloride of mercury. In cases where the congestion is as great as the one described, it is not advisable to use silver nitrate until the congestion has been considerably reduced. In milder cases the conjunctiva is brushed over, after irrigation, with 2 per cent silver nitrate (*see* p. 431 for precautions). The eye should be irrigated every half-hour with a mild boric acid or normal saline solution, and I prefer to use a douche so that a good flow can be directed into the eye. The most serious danger arises from corneal complications, so that great care must be exercised not to injure the cornea during any of these manipulations. No care, however, will prevent the affection of the cornea in a large percentage of cases. When this happens, atropine should at once be used, and mercurial lotions replaced by boric acid or normal saline. Boric acid ointment should always be put between the lids and over any raw surface before the patient goes to sleep. It is some hindrance to the formation of adhesions. The secretion from the eye remains capable of carrying infection as long as there is the slightest trace of inflammation.

Chronic Conjunctivitis may be a sequel of acute, and especially in gouty or rheumatic subjects the conjunctiva tends to remain in a slightly inflamed condition. Mildly astringent lotions, e.g. of zinc sulphate (1 or 2 gr. to the ounce) or of boric acid with hazeline (20 min. to the ounce), are usually sufficient to cure such cases. In gouty

people, lotions containing zinc sulphate sometimes increase the irritation, and if there is definite evidence of chronic gouty inflammation in mucous membranes elsewhere, e.g., a gouty pharyngitis, it is better to use a mild alkaline lotion of biborate of soda. If the inflammation persists, a single painting with 1 per cent silver nitrate will often work wonders, especially in gouty people. More than 50 per cent of all cases of conjunctivitis occur in the form of chronic angular conjunctivitis (diplobacillary conjunctivitis).

Chronic Angular Conjunctivitis.—The clinical picture it presents is a fairly straightforward and consistent one. It mostly occurs in adult life, and when it attacks children it is very apt to cause marginal blepharitis. The patient comes with the complaint that the lids are gummed together in the morning, or very heavy, and that they have to be bathed with warm water to get them to open at all. This process is sometimes painful, but shortly the pain passes off, and during the day the eyes feel fairly comfortable. Towards evening the eyes begin to prick, especially in the corners. This may commence so sharply that a man will assert that he has got a bit of grit into his eye, and will tell you exactly where he was when the grit went in. The neurasthenic patient will tell you that the whole upper lid feels as if a dustbin had been emptied into it, and the ball of the eye feels hot and fiery. The discomfort during the evening may be very considerable, even giving rise to headache, and is nearly always accompanied by a desire to scratch the inner angles of the eye. Usually a period of three or four days elapses between the infection of the two eyes, the incubation period of the organism (the diplobacillus of Morax) being from three to five days. Objectively the most obvious sign is the reddening and inflammation of the angles of the eye and the lid margins. The caruncle is usually bright red. Along the roots of the lashes there is a fine greyish deposit, and at the inner angle a little mass of greyish-yellow fibrinous matter in which usually great numbers of the organism can be found. The palpebral conjunctiva is usually slightly inflamed and somewhat roughened, but the ocular conjunctiva, apart from the angles, is seldom much affected. The most characteristic feature, apart from the angular redness, is the erythematous condition of the skin of the lids. Usually the skin at both angles has a slightly eroded appearance, and the rest of the skin along the margins has a dry, crackly, semi-glazed appearance, as if it had been badly starched. The disease usually commences in a subacute fashion, becomes chronic, and persists for many months if untreated. As the symptoms are often mild, it may be many months before treatment is sought.

The Treatment to be adopted is a lotion containing one or two grains of zinc sulphate to the ounce, made up with a little cherry-laurel water. This smarts—in some cases it smarts very badly—and you have to warn people of it ; but in no case must you prescribe a little cocaine with it just to take away the pain. If you do, the

relief is immediate, but in a short time the congestion recurs, and, like dram-drinking, the effect is shorter with each dose, and in a week or ten days you get a sodden condition of congestion much more difficult to treat than the original inflammation. A similar condition of chronic congestion may result from the long-continued use of a lotion or drops containing adrenalin. Argyrol is of service in some cases, but the mainstay is zinc sulphate. For the comfort of the patient it is advisable to prescribe a simple ointment, to be used at night, to prevent the gumming of the lids.

Follicular Conjunctivitis.—There are normally present in both upper and lower fornices of the conjunctival sac rows of lymphatic follicles. In certain types of children, these readily become enlarged in response to slight irritation, and form chains of small, pearly-looking granules in the fornices. The class of child who is most likely to show this condition may also have other lymphatic enlargements, e.g., hypertrophied tonsils or adenoids. The condition is of little local importance, but is of value as an indication of the necessity of revising the general circumstances of the child's life and of securing its removal from the influences of stuffy school-rooms and bedrooms. I mention it here, as it is of importance to be able to differentiate it from trachoma, one of the most severe of conjunctival diseases.

Trachoma (Granular Conjunctivitis, Egyptian Ophthalmia).—In its typical form the granules, varying in size from a small hemp-seed to a lentil, are scattered all over the tarsal surface of both lids, and are not restricted, as in follicular conjunctivitis, to the fornices. There is a form of trachoma, however, in which there are no obvious granules, but only a more or less uniform thickening and infiltration of the conjunctiva on the tarsal surface. This usually occurs when the disease has an acute onset. When the tarsal surface shows definite granules, varying in size and irregularly distributed, there is no difficulty in separating the condition from follicular conjunctivitis. The palpebral form of spring catarrh (a comparatively rare disease in this country) can usually be distinguished by the granules forming a more definitely circumscribed patch ; they are flat-topped and form a mosaic somewhat like a cobble-stone pavement, and when the eyelid is everted for a few seconds the free secretion of mucus produces a bluish milky appearance. Examination of the lids alone, in the majority of cases, suffices to differentiate trachoma from other forms of conjunctival disease. In doubtful cases the determining factor is the presence of pannus, the invasion of the superficial layers of the cornea underlying the epithelium by connective tissue carrying blood-vessels. To examine for the earliest stage of pannus a corneal loupe is necessary. In a normal eye the conjunctiva overlaps the margin of the cornea as a greyish translucent band with a sharp, clear-cut edge. The terminal twigs of the conjunctival vessels can be seen reaching this edge, but never passing it. In the earliest stages of pannus the edge loses its clean-cut appearance and becomes ragged,

and here and there tiny vessels can be traced on to the cornea. In well-marked pannus due to trachoma, the main course of the vessels is vertical, and mostly from the upper margin. When the pannus is advancing, there is a greyish area in the cornea beyond the vascular region.

THE TREATMENT of trachoma must be both drastic and persistent. In a severe case where the trachoma bodies are well marked but not hard, they should be expressed by means of Grady's forceps (*Fig.* 251) or Knapp's roller forceps (*Fig.* 252). As this is a very painful process, and as it is essential that it should be done thoroughly, it is advisable to give a general anæsthetic, though some cases will tolerate it after thorough cocainization. The operator puts on goggles, and then grasps the everted tarsal plate between the blades of the forceps and forcibly expresses the contents of the follicles. A solution of perchloride of mercury in glycerin (1–100) is then brushed in with a hard tooth-brush, the sacs are washed with boric acid lotion, and boric acid ointment is put between the lids. Where the granules are harder, expression must be replaced by scarification. The everted lid is supported on a horn spatula and scarified with a Beer's knife (*Fig.* 249). The first incisions should be made over the most prominent granules, and these may be scraped out with a small Meibomian curette (*Fig.* 253). The lids are then brushed with the strong perchloride solution and treated as before. Usually much reaction follows this treatment, and iced compresses will be found useful till it subsides. During this period the eyes should be bathed frequently with boric acid lotion, and ointment should be applied night and morning.

Fig. 251.—GRADY'S EXPRESSION FORCEPS.

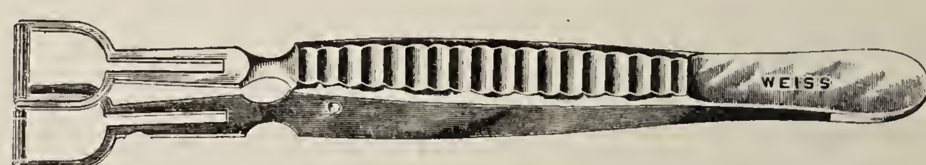


Fig. 252.—KNAPP'S ROLLER FORCEPS.

Fig. 253.—MEIBOMIAN CURETTE.

The subsequent treatment of these cases is the same as for milder ones. The affected surface is rubbed once daily with a stick of copper sulphate, and the patient uses a lotion of boric acid and zinc sulphate. At the end of a month the applications can be reduced to three a week, and later to two or even one a week. A marked improvement usually manifests itself in three or four weeks, but often after a time the case seems to come to a standstill. The substitution of silver nitrate for the copper sulphate, either as a 2 per cent solution or in the solid form known as mitigated stick, will then be beneficial. In

fact this variation in the treatment from time to time is advisable in all cases, and it is also useful to allow periods of freedom from any treatment other than a simple astringent lotion. Many other forms of treatment have been suggested and tried from time to time, such as X rays, radium, and carbonic-acid snow. Most of them have had a considerable vogue for a short time, and then been again replaced by older methods.

AFFECTIONS OF THE CORNEA.

Injuries.—*Abrasions* of the cornea are apt to be overlooked, since when fresh the transparency of the cornea is not interfered with. When any corneal injury has taken place, and an abrasion is suspected, a drop of fluorescein will stain the denuded area a bright green. The eye is bathed, a drop of atropine is instilled, and a pad and bandage are applied. Boracic bathing should be repeated every four hours. As a rule, the pad can be taken off in twenty-four hours. If the surface is not covered in that time, another drop of atropine should be put in and the pad replaced.

Foreign Bodies embedded in the cornea are mostly particles of steel or emery from the emery-wheel or grit from an engine. Careful examination with a loupe is often required for their detection, as they are frequently very small and difficult to find. A drop of fluorescein is of great assistance in doubtful cases, the staining area indicating the position of the foreign body. Another useful indication is a slight but definite contraction of the pupil on the affected side due to reflex irritation of the iris. This is often accompanied by some ciliary flush, occupying that part of the limbus which is adjacent to the foreign body. The removal must be done with as little injury to the corneal epithelium as possible. Occasionally, after dropping in a little 4 per cent cocaine, the foreign body may be so loosened that it can be removed by means of a little cotton-wool, soaked in boric acid, on the end of a glass rod. If this does not suffice, a corneal spud should be used (*Fig.* 254), and the removal must be complete. The eye is well cocainized, and a strong light focused on it by an assistant. The patient is told to look fixedly in whatever direction enables the operator to get the best view of the object to be removed. If the spud fails to remove it, recourse may be had to a discission needle (*Fig.* 255), but in digging out foreign bodies with this, care must be exercised not to injure the cornea more deeply than is necessary. After removal, bathe carefully, put in a small piece of atropine ointment, and bandage the eye.

Fig. 254.—Corneal Spud.

Fig. 255.—Discission Needle.

Perforating Wounds of the Cornea may be simple, or may be complicated by prolapse of the iris, by prolapse of the ciliary body if the sclera be involved in the wound, and by injury to the lens. If the wound is uncomplicated by any prolapse of iris, and the lens has not been wounded, the conjunctival sac must be well douched with boric acid lotion, and strong atropine ointment (2 per cent) at once put in. Both eyes should be bandaged, and the patient kept at rest in bed. Atropine ointment 1 per cent should be put in twice a day gently, and the eye should be examined once a day in view of prolapse taking place subsequently.

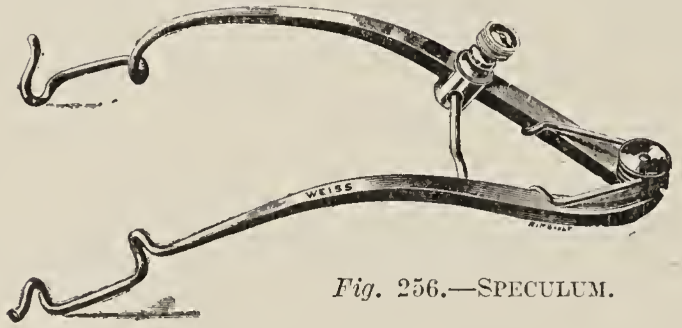


Fig. 256.—Speculum.

When there is prolapse of iris complicating a wound, it is best to give the patient a general anæsthetic. It is well to have the following instruments ready: speculum, fixation forceps, iris forceps and de Wecker's iris scissors, keratome, and repositor (*see Figs.* 256–261). I also prefer to have ready a McKeown's wash-bottle (*Fig.* 262) filled with normal saline at 102°, in case I may wish to wash out the anterior chamber. Thoroughly cleanse the skin round the eye, clip off the eyelashes, and douche out the sac with normal saline. Insert the speculum and then douche the wound gently. Seize the prolapsed iris with the iris forceps, and gently work the iris out of the wound, so as to have it freed from any adhesions that may have already formed. Keep it on the stretch, and cut off close to the cornea. The elasticity of the iris will then pull the pillars away from the wound. Put in some 1 per cent atropine solution, and pad and bandage both eyes.

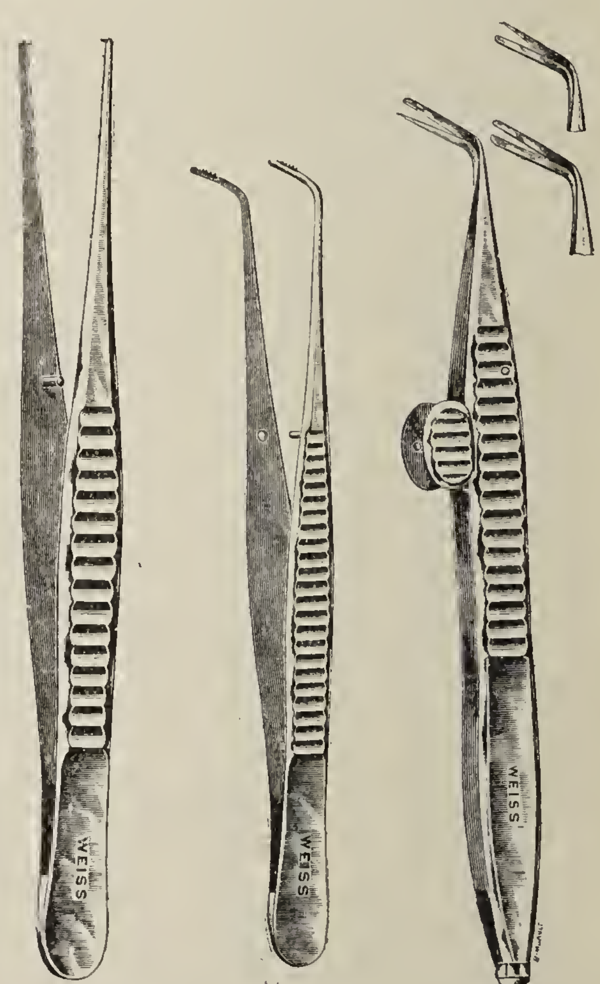


Fig. 257. Fixation Forceps. *Fig.* 258. Iris Forceps. *Fig.* 259. De Wecker's Iris Scissors.

Sometimes the iris is too firmly caught in one of the angles of a ragged wound to be freed in this way, and yet it is most essential for the safety of the eye that it should be freed. In such a case, do not try to free the iris by opening up the old wound, but make a fresh opening at the corneal margin

with the keratome, choosing a point which will allow easiest access to the adherent part of the iris. Be careful not to injure the lens with the point of the keratome. Then insert the iris forceps and take a firm grip of the iris round the adherent part, draw it out through the keratome wound,

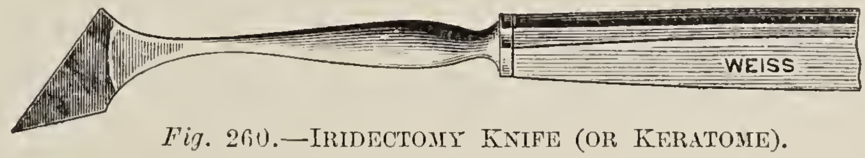


Fig. 260.—Iridectomy Knife (or Keratome).

and cut off with iris scissors. Get the pillars of the iris coloboma back into position with the repositor; then wash out the anterior chamber with the McKeown wash-bottle. Put in atropine, and treat as before.

Fig. 261.—Iris Repositor.

When the wound passes from the cornea into the sclera there comes the additional danger of prolapse of the ciliary body into the wound. These cases are always a source of grave anxiety, and yet if the wound has not been caused by a dirty implement, many eyes are saved which in earlier days would have been at once excised. In treating them, the prolapsed iris and ciliary body are first drawn out and cut off. Then a very sharp, small, curved needle armed with finest silkworm gut is passed through the superficial layers of the edges of the scleral wound near the

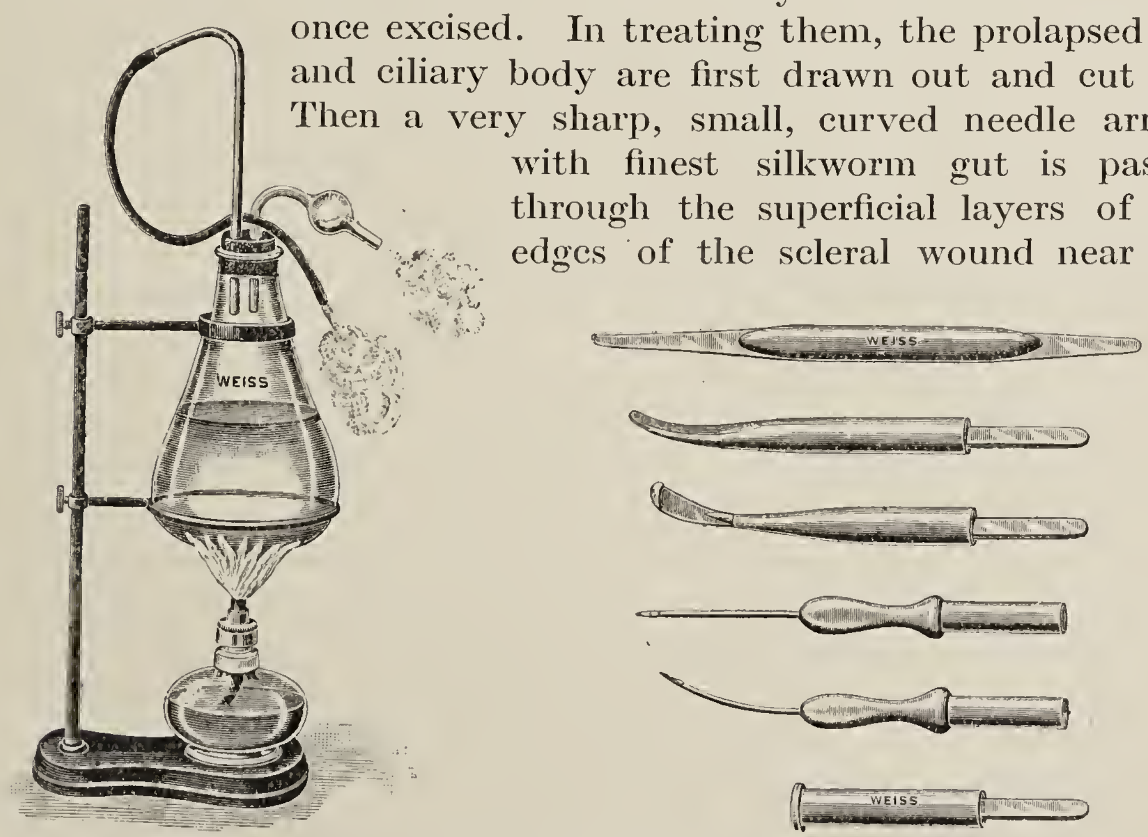


Fig. 262.—McKeown's Irrigating Apparatus.

cornea. This must be done with as little pressure on the eyeball as possible; hence the necessity for a very sharp needle and for catching up only the superficial layers. If the wound passes far into the sclera, a second stitch may be inserted. Then bring a flap of the conjunctiva down over the wound, cutting away the conjunctiva below, so that the scleral wound is covered by conjunctiva and the conjunctival sutures are away from the scleral wound.

Injury to the lens and consequent swelling of lens matter is a serious complication in all these cases. It interferes with the freeing of the iris from the wound, and it presses the iris forward even when it is free, so that a subsequent adhesion may form. In addition to that, the lens capsule may be prolapsed into the wound, and the swelling lens matter seems to form a favourable culture medium for organisms, so there is greater danger of sepsis.

In all cases of perforating wounds, whether simple or complicated, the house surgeon must be carefully on the outlook for keratitis punctata. It is not the eye which passes into a condition of general suppuration which is most likely to set up sympathetic ophthalmia: such an eye is removed, and with its removal usually all danger is past; but the eye which remains inflamed and irritable, and in which there appear on the back of the cornea the tiny round dots of punctate keratitis, is almost certain, if left, to cause a sympathetic inflammation in the other eye. Such an eye ought to be excised at once.

It has been demonstrated that, when sympathetic ophthalmia is threatening, the blood-count shows a characteristic change, a marked increase in the relative proportion of large mononuclear leucocytes to polymorphs. In various protozoal infections a similar blood change is known to take place, and the progress of these diseases is often arrested by the use of salvarsan. In consequence of this analogy, salvarsan has been used in cases of threatening sympathetic ophthalmia, and has proved of very great value.

Corneal Ulcers, if not severe, will usually react favourably to very simple treatment. The first essential is to secure rest for the eye. For this purpose atropine drops ($\frac{1}{2}$ per cent) are put in, and the eye is covered with a pad lightly bandaged on. Only in cases where the ulcer is complicated by conjunctivitis with a large amount of secretion is this latter abandoned. The atropine paralyzes the action of the iris and ciliary muscles, and so acts as a physiological splint, while the pad keeps the eyelids at rest over the cornea. Frequently during the day, the eye should be bathed with warm boric acid lotion. It is advisable in all cases of corneal ulceration to inquire into the habits of the patient. In children especially, attention should be given to the condition of the alimentary tract. Small doses of compound rhubarb powder (10 to 15 gr.) may be prescribed, to be taken three times a day. In adults, a pill of calomel and colocynth at night, followed by a saline purge in the morning, is often of great service in initiating the treatment.

When the ulcer is of a more severe nature, it becomes necessary to adopt other local measures. Of these the most generally useful is painting with pure carbolic acid. First put in two drops of cocaine, and then a drop of fluorescein (being careful to sop up any excess with a pad of absorbent wool). After a few seconds wash out the fluorescein with cocaine, and the ulcer will be found stained bright

green. With two fingers of the left hand hold the lids gently apart; dry the surface of the ulcer with a small piece of sterilized blotting-paper, and touch the whole stained surface with a small camel-hair brush soaked in pure carbolic acid. The end of a wooden match carefully pointed and soaked in carbolic is an excellent substitute for the brush. If the ulcer is of the advancing type, most attention should be devoted to the advancing edge. The cautery can be used with equally good results. The benefit of using pure carbolic is that it is itself an anæsthetic. In using the cautery, a dull-red heat is required, and the touching should be done very lightly. After cauterizing or touching with phenol, continuous boric acid fomentations, with free hot bathings at each change, and atropine drops twice a day, should be ordered.

Pus forming in the anterior chamber (hypopyon) is not in these cases a sign of serious inflammatory involvement of the iris and ciliary body. The pus is usually sterile, and its formation is due to the chemiotactic influence of strong toxins diffusing into the anterior chamber through the corneal membrane. It is probably most frequently seen in pneumococcal ulceration. It may form very rapidly, and with a healing ulcer it will absorb as rapidly as it forms. If it is necessary to perform paracentesis, the hypopyon should be washed out with normal saline.

When an ulcer is deep and there is a likelihood of perforation, no treatment is so valuable as paracentesis. If an ulcer is allowed to perforate spontaneously, it is almost certain that the iris will prolapse in the rush of aqueous that takes place, and, lying in contact with the edges of the ulcer, will certainly become adherent if not removed (*see* p. 438, operation for removal of prolapsed iris, under 'Perforating Wounds of Cornea'). If the floor of the ulcer is incised (usually called Sæmisch section) and the aqueous allowed to escape gently, a valvular opening is formed; and the iris, if it does come in contact with the back of the cornea, is in contact with healthy and not with inflamed tissue. In addition, re-formation of the anterior chamber soon takes place and separates the iris from the cornea, while in spontaneous perforation it may be some days before the anterior chamber re-forms.

In performing this little operation, I prefer to use an old, much-ground Graefe knife. Cocaine anæsthesia is sufficient for all cases except young children. The eyelids are held apart by a speculum, and the eye steadied with fixation forceps. Enter the knife at the edge of the ulcer farthest away from the corneal margin, holding it so that it points obliquely towards the angle of the anterior chamber. As soon as the point has perforated, depress the handle so that the knife is almost horizontal, and carry it through the base of the ulcer, so that it just reaches the healthy tissue on the other side. Put in some atropine after washing out the conjunctival sac, and pad and bandage lightly.

THE LACHRYMAL APPARATUS.

Lachrymal Obstruction.—The most frequent cause of epiphora (overflow of tears) is obstruction of the tear-duct, the result of chronic dacryocystitis. Epiphora may also be caused by displacement of the puncta lachrymalia in congestive conditions of the eyelid or in senile ectropion, but in the great majority of cases the site of the obstruction is the upper part of the tear-duct where it leaves the sac. In treating this condition, the course of action to be adopted must vary in different cases. (1) The obstruction may be the result of simple congestion. (2) Chronic inflammatory changes may have resulted in developing a band of cicatricial tissue at the upper end of the duct. (3) The obstruction may be bony, following on syphilitic periostitis or on fracture of the bones forming the walls of the duct. (4) It may be due to a growth. In the first case the lachrymal sac will not be dilated, but in the other cases there will be a small swelling under the inner tarsal ligament (mucocele), the contents of which will regurgitate into the eye on pressure. These may be either mucous or mucopurulent in character.

The first step in treating all these cases is to syringe out the sac carefully with boric acid lotion. A little fluid may pass into the nose, but probably it will all come back into the eye by the upper punctum. After two or three syringefuls the fluid will come back clear. If none at all has passed into the nose, a small syringeful of cocaine 2 per cent in 1–5000 adrenalin should be washed into the sac and left there for a few minutes. This will reduce the congestion and allow fluid to pass down into the nose. To finish up the treatment on the first sitting, fill the sac with 25 per cent argyrol. The patient is to be instructed to bathe the eye frequently with boric acid lotion, carefully pressing the finger into the corner of the orbit, so as to squeeze out the contents of the sac between each application of the lotion. He should also be given weak zinc sulphate drops or argyrol* (10 per cent) drops, to be put into the eye three times a day.

The syringing should be repeated daily, or at least every second day. In the simpler cases, a good passage will be established in from ten days to a fortnight, and in the others the condition of the sac walls will be much healthier. If the duct is still blocked after ten days, it becomes necessary to attempt to re-establish the passage by probing: but if the sac be very much dilated, the walls have probably become atonic, and a mucocele will persist even if there is a passage established. In these cases it is better to proceed directly to excise the sac than to put the patient to the useless worry of probing (*see* below).

In probing the sac, the lower punctum is first dilated with the

* Argyrol should never be ordered as drops for home use without giving warning against too prolonged use. Staining has occasionally resulted from it.

punctum dilator on the end of the Weber's knife (*Fig.* 263). Weber's knife has a probe point which originally was curved, but is now usually made straight. The knife is passed into the dilated punctum and then held horizontally, with the edge pointing up and in. The lower lid is pulled outwards and kept on the stretch, and as the knife passes into the sac, the canaliculus wall is slit on its inner aspect. The opening is enlarged by bringing the knife to the vertical, keeping the lid stretched. Stilling's knife (*Fig.* 264) should be used to enlarge the opening into the sac. The canaliculus being slit, take No. 3 or 4 Couper's probe (*Fig.* 265), dip the point in cocaine vaseline, and pass it horizontally along the open canaliculus into the sac. It should meet with no resistance until it can be felt tapping against the lachrymal bone. (Sometimes the point catches in a fold of mucous membrane. Do not use force to pass this.) Now rotate the probe until it is vertical, keeping the point in position with the index finger of the other hand. The probe should now point directly to the fold of the ala nasi. Keeping the point of the probe a little backwards, it will then be felt to engage in the opening of the duct. If the line above indicated is kept, it will pass down the duct into the inferior meatus of the nose. A No. 6 probe should next be passed in a similar manner, and allowed to remain in position for five or ten minutes. Do not syringe *immediately* after probing. The patient must be seen daily for two or three days to prevent the canaliculus walls reuniting, and each time the sac should be gently syringed. On the fourth day a No. 4 probe should again be gently passed down the duct, and for about ten succeeding days the sac should be syringed with a mild astringent lotion. Be very chary of using any organic preparation of silver after probing. I have seen three cases of permanent black eye resulting from argyrol or protargol being driven into the orbital tissues. If the obstruction is found to be impermeable with a No 3 Couper probe, or if the stricture is obviously bony, it will be found advisable to have the sac excised.

Fig. 263.—Weber's Knife.

Fig. 264.—Stilling's Knife.

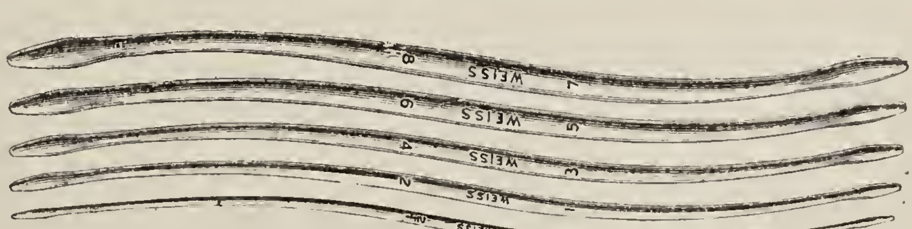


Fig. 265.—Couper's Probes. ($\times\frac{5}{8}$.)

Excision of the lachrymal sac is more frequently advised at present than was formerly the case. Some writers go so far as

to say it should always be done if simple syringing will not cure the obstruction. To object entirely to probing is an extremist's view, but to persist in probing a duct which constantly becomes re-obstructed is folly.

In recent years the operation of removal of the lachrymal sac has largely been replaced by one or other of the operations for procuring a fresh opening into the nose by intranasal methods of operation. The most effective is West's operation. In this a fold of mucous membrane is turned back opposite the anterior end of the middle turbinal, a circular opening is chiselled in the bone opposite the inner wall of the sac, and through this hole the inner sac wall is pushed and as much as possible of it removed. A corresponding hole is cut in the flap of nasal mucous membrane, which is then replaced in position, and kept there by plugging or by passing a lead wire through from the canaliculus.

Acute Dacryocystitis.—Acute inflammation of the tear-sac is most frequently an incident in the history of a chronic lachrymal obstruction. It manifests its presence by a red swelling, most marked immediately below the inner tarsal ligament. As suppuration progresses, the abscess tends to open on to the cheek just about the lower orbital margin, and after evacuation a lachrymal fistula may be left in this position. The treatment of a lachrymal abscess which does not show signs of pointing consists of slitting up the lower canaliculus freely, so as to provide a better means of escape for pus from the sac, and then free fomentation. If the abscess shows signs of coming to a head, it should be opened and evacuated freely, the sac gently scraped, and the cavity plugged with gauze and then fomented. It is most inadvisable to attempt to probe during an attack of dacryocystitis. It may set up a most severe orbital cellulitis, followed by retro-bulbar neuritis and consequent blindness.

EXCISION OF AN EYEBALL.

The instruments required are an eye speculum, two pairs of fixation forceps, tenotomy scissors (curved on the flat) and hook, and a stout pair of excision scissors (curved on the flat) (*see Figs.* 266–269). A general anæsthetic is used. If the operation is being done as an emergency, the skin should be well washed with soap and water and then with 1–2000 perchloride of mercury, and the conjunctival sac washed out with the same lotion. Then, having inserted the speculum, catch up a fold of the conjunctiva at the side of the cornea, and snip through it between the forceps and the corneal margin. Through the hole thus made, insert both blades of the scissors and free the conjunctiva from the subconjunctival tissue, first on the upper and then on the lower side of the cornea. This enables the operator to cut the conjunctiva in its whole circumference with two cuts. Next pick up the conjunctiva, and holding it away from the globe, free it with the scissors all the way round. In doing this, keep

as close to the globe as possible, so as to open Tenon's capsule freely. Then catch up each of the recti muscles in succession with the tenotomy hook and cut them close to the globe. (It is advisable to commence with the superior rectus.) If now the speculum is opened widely and pushed backwards, the globe should dislocate forwards.

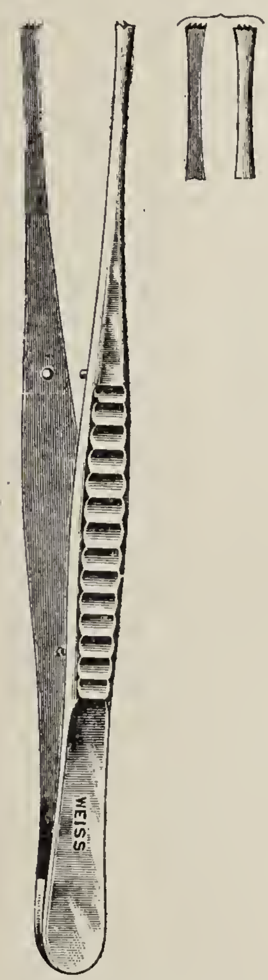


Fig. 266.
Fixation Forceps.

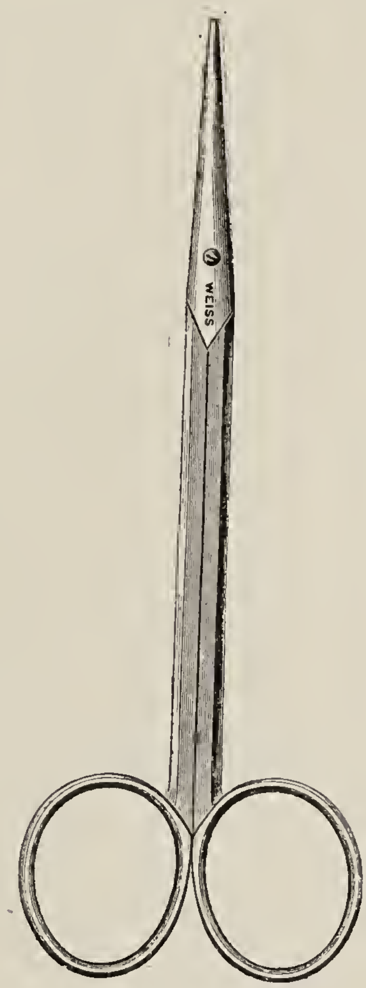


Fig. 267.
Tenotomy Scissors.

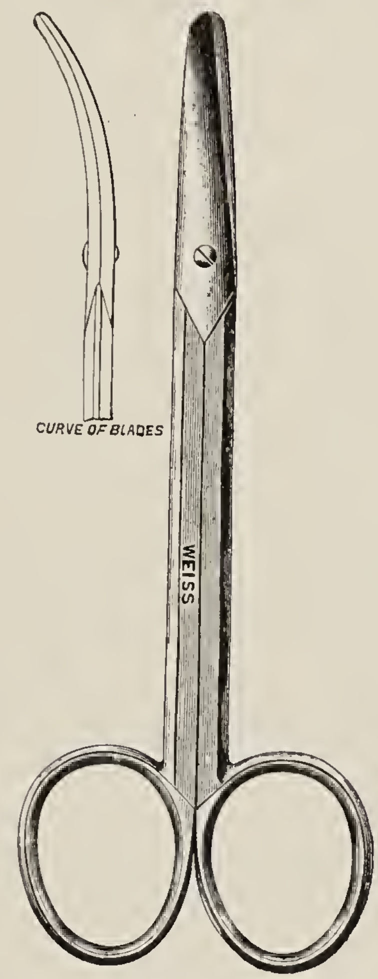


Fig. 268.
Excision Scissors.

Catch it between the finger and thumb, and pass the closed excision scissors back close to the globe to the outside or inside, whichever is most convenient. When you feel them touching the optic nerve, they are opened, and when they embrace the nerve, push them gently backwards, and then cut through with one cut. The eye will then

Fig. 269.—Hook for Use in Excision of an Eyeball.

come forward easily, and the removal is completed by cutting through the oblique muscles and the rest of the tissue close to the globe. Douche out the socket with very hot saline, and plug it for a short time until the bleeding stops. Then with the two pairs of fixation forceps pick up the edges of the conjunctiva and bring them into apposition. No stitches are required. Plug the cavity outside the

conjunctiva with gauze, and put on a pressure dressing. The gauze plugging is removed in twenty-four hours, and it seldom has to be renewed. Do not let adhesions form during the healing process.

SIMPLE TENOTOMY.

This operation is usually done for minor degrees of strabismus, varying from 8° to 15°. Some surgeons use the simple operation with success for even larger angles of squint than those given, but if the squint is over 20° there is little chance of tenotomy alone being sufficient to cure the error. In that case tenotomy of the one muscle (the internal rectus in convergent strabismus) is combined with advancement of its opponent (the external rectus). Tenotomy is usually performed with a local anæsthetic, except in young children. The anæsthetic used is 4 per cent cocaine in 1–2000 adrenalin. The instruments required are an eye speculum, fixation forceps, tenotomy scissors (straight), and tenotomy hook. One stitch of finest silk will also be required.

A tenotomy may be done by the open method or subconjunctivally. The latter method requires more skill, and is liable to lead to certain complications, while the only disadvantage of the open method is that a stitch has to be taken out two or three days after the operation. I shall describe only the open operation for tenotomy of the internal rectus. The conjunctival sac having been anæsthetized and then washed out with normal saline, insert the speculum. Then, standing at the side of the patient corresponding to the eye you are going to operate on, pick up the conjunctiva over the insertion of the internal rectus. (Remember that the external rectus has its insertion farther back than the internal.) Cut through the conjunctiva in a vertical direction. The cut should be about a centimetre in length. Pick up the tissue at the lower border of the tendon (Tenon's capsule) and snip through it, and clear the lower border of the tendon slightly. At this point it is advisable to apply another couple of drops of cocaine and adrenalin, leaving it to act for a minute. Then pass the point of the tenotomy hook well backwards through the hole in Tenon's capsule, and bring it gently forwards under the muscle. The point of the hook will now show at the upper border of the tendon. It should be freed from the capsule which covers it, and then the tendon can be divided with one cut of the scissors between the tenotomy hook and the globe. Pass the tenotomy hook backwards again to catch up any small strands that may have been left undivided. To finish the operation, all that is necessary is to join the lips of the conjunctival wound by a single stitch.* Wash out the conjunctival

* A tenotomy for concomitant convergent squint should never be done until the patient's refraction has been estimated and if necessary new glasses ordered.

sac with normal saline, and bandage the eye. The eye should be bathed twice a day, and on the third day remove the stitch and at once put on the patient's correcting glasses.

The operation of *recession* is an alternative procedure in which the tendon of the internal rectus is anchored to the sclera with stitches at a certain predetermined distance behind its original insertion. The distance separating the new insertion from the original one depends upon the degree of squint to be corrected.

CATARACT.

Treatment of a Cataract Patient.—When possible, a patient who is going to have a cataract extraction should be admitted to the hospital two days before the operation. On the evening of admission a culture and a smear should be taken from the conjunctiva of the lower lid of the eye to be operated on. The culture should be incubated for forty-eight hours. The presence of a few colonies of *B. xerosis* or of *Staphylococcus albus* is considered of no pathological importance; but if any other organisms be present, operation must be delayed until local treatment with lotion and drops has rid the conjunctiva of their presence. Of course, any grosser inflammation of the conjunctiva or obstruction of the tear-duct must be treated and cured before the operation can be performed. Meantime, the urine should be examined (especially for sugar). The evening before operation a mild laxative should be given; drastic purging is quite unnecessary, and may even be disadvantageous, since in some people it leads to constipation in the following days, and that is one of the dangers to be avoided after cataract extraction. The patient should have a light, digestible breakfast on the morning of the operation. Twenty minutes before the time fixed for operation, some 5 per cent cocaine in 1–2000 adrenalin should be dropped into the eye; this is repeated in ten minutes, and again just before the patient goes to the theatre, the eye being kept covered between the instillations. The patient usually walks to the theatre.

Fig. 270.—Graefe's Cataract Knife.

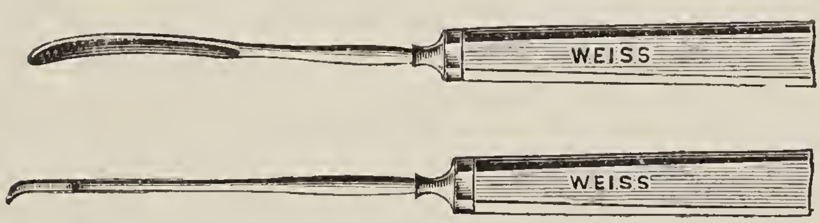


Fig. 271.—Moorfields Curette and Cystotome.

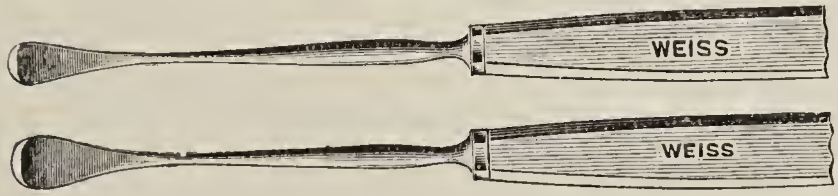


Fig. 272.—Critchett's Cataract Spoons.

The eyelashes should be cut short, and the skin of the eyebrows and eyelids sterilized with iodine solution.

The instruments which should be put out for cataract extraction with iridectomy are a speculum, two pairs of fixation forceps (one broad and one narrow), Graefe's cataract knife (the point of this

Fig. 273.—Taylor's Vectis.

should be tested on the drum and should go through the kid without the least resistance), iris forceps and iris scissors (de Wecker's), curette and cystotome, and repositor. It is also advisable to have in readiness either a lens scoop (Critchett's) or a vectis. Some surgeons use special capsule forceps to tear off a portion of the anterior lens capsule instead of cutting it with the cystotome. The instruments (*see Figs.* 270–274) are placed in a special porcelain tray, and the sterilizer should be large enough to take the tray with all the instruments. It is advisable to sterilize the Graefe knife separately, lest anything should happen to the delicate point from carelessness in putting in the tray and taking it out.

Fig. 274.—Couper's Capsule Forceps.

After-treatment of Cataract Extraction.—After the operation the patient must be carried back to bed with as little disturbance as possible. To facilitate this it is desirable to have under the patient a strong canvas sheet, with places at each side through which poles can be slipped, to lift him from the operating-table to the trolley and from the trolley to the bed. He must lie perfectly quietly on his back for the first three or four days. At night the sleeves of the night-dress should be pinned down to the breast, to prevent the patient rubbing the eye during sleep or on waking in the morning. At the end of twenty-four hours the eyes are uncovered and the eyelids gently bathed until they can open. A drop of atropine is instilled, but no attempt should be made to see the wound. This bathing should be repeated on the second day, and only on the third day should the wound be examined. After the fifth day, only the eye operated on is covered, and the patient is allowed to sit up in bed. During the first three days the food should be soft. There is no need for it all to be fluid, but nothing should be given which requires mastication. If the bowels do not act naturally, no aperient should be given until after the third day. The patient must be warned not to sneeze. Any tendency to do so can be checked by pressing firmly on the middle

of the upper lip. On the seventh day the patient is allowed out of bed to sit on a chair, and on the tenth day the bandages are given up and dark protective glasses are put on. During this period the atropine drops are put in once a day, but if the eye is quiet on the tenth day this may be stopped. The patient may leave the hospital as soon as the dark glasses are fitted. He should continue wearing these until the proper correcting glasses are ordered. It has become the practice of many surgeons now to leave the eye uncovered by pads from the first, simply using a protective shield. There is much to be said in favour of the practice, as the mere covering in of a perfectly healthy, untouched eye may cause a certain amount of discharge to develop.

ACUTE GLAUCOMA.

It is very desirable for the house surgeon to know the main points in the diagnosis between acute glaucoma and acute iritis. It is necessary to realize that the intra-ocular tension may be as high in the one as in the other, so that point by itself is of little value. In acute iritis the pupil is usually small and the iris sluggish in reaction ; in acute glaucoma the pupil is dilated, often oval with the long axis vertical or nearly so, and the iris is fixed. In iritis the iris looks congested and muddy ; in glaucoma it looks flattened and atrophic. In iritis the anterior chamber of the eye may look deeper than normal ; in glaucoma it is shallow and may be absent towards the periphery of the cornea. In glaucoma the circumcorneal congestion is apt to be coarser in character than in iritis. Even when the diagnosis remains doubtful, there are certain lines of treatment which may safely be adopted pending the arrival of the surgeon. The most important of these is to attempt to relieve congestion both by local and general means. Give a free purge (pil. calomel c. colocy. gr. v, followed by haust. alba ℥ij), and apply three or four leeches to the temple outside the bony margin of the orbit. If the diagnosis of glaucoma is certain, drop a $\frac{1}{2}$ per cent solution of eserine into both eyes at once, and repeat every hour in the affected eye ; but if there is any uncertainty it is advisable to wait the arrival of the visiting surgeon before using either eserine or atropine in any form. It is advisable to have the patient prepared for a general anæsthetic.

CHAPTER XLII

DISEASES OF THE NOSE AND THROAT

DISEASES OF THE NOSE.

A KNOWLEDGE of nasal disorders is of importance for three reasons : (1) Conditions leading to nasal obstruction are very common in practice, and very distressing to the sufferer ; (2) Nasal obstruction is primarily responsible for many of the disorders of the pharynx, larynx, and ears, and, as in the case of adenoids, for diminished physical and intellectual growth ; (3) Nasal suppuration initiates or maintains many disorders due to septic causes.

Examination of the Nose. — Examination must be conducted methodically and minutely. The patient sits facing the examiner, who reflects, by means of a forehead mirror, a strong light to the part required. The light should be placed just behind and above the patient's left shoulder. The nose must be examined from the front (anterior rhinoscopy) and from behind (posterior rhinoscopy).

Fig. 275.—POSTERIOR NARES.

For Anterior Rhinoscopy, the anterior nares are kept open by means of Thudichum's speculum, the spring of which is held by the left hand in front of the patient's nose. A view is obtained of the anterior part of the septum, floor, and inferior and middle turbinal bodies ; and if a 2 per cent solution of cocaine be applied, the consequent shrinking of the mucous membrane will allow of a still more extended view.

Posterior Rhinoscopy requires more practice, but the trouble will be well repaid, if it is remembered that the only alternative to posterior rhinoscopy is examination with the finger, a method which is strongly objected to by children and adults—and rightly, for a finger examination, except in very young or fretful children, or for some special purpose, e.g., to estimate the consistency of a growth, is a sign of

incompetence in the practitioner. For the examination, the smallest laryngoscopic mirror is chosen (it is quite unnecessary to use Michel's hinged rhinoscope), and carefully warmed by a spirit lamp ; the tongue being gently depressed by a spatula held in the left hand, the mirror is passed behind the soft palate to one side or other of the uvula. The mirror is then rotated until the free edge of the septum—a pale pink vertical edge—is seen. You have now obtained your bearings, and the roof of the nasopharynx, the openings of the Eustachian tubes, and the posterior parts of the turbinals should be examined (*Fig.* 275). The difficulties of the method are nearly all of one's own making. The position of the tip of the tongue-depressor (far back, near the foramen cæcum), the amount of pressure required, the passage of the mirror along the tongue-depressor so that it does not touch the patient at all, are all matters that can be acquired by practice, and practice alone. The patient should be asked to breathe through the nose while the examination is proceeding. Some children are of course fretful and refractory at times, but most of the fretfulness is caused by clumsy pressure with the spatula.

NASAL OBSTRUCTION.

Under this heading may be grouped those conditions leading to partial or complete blocking of the nose, with the resulting necessity for mouth breathing. Of these, the commonest are adenoids (which will be considered presently), hypertrophy of the mucous membrane covering the turbinals, deviations of the septum, and polypi. In later life a unilateral obstruction may be due to malignant disease of the upper jaw.

Hypertrophy of the mucous membrane covering the turbinals (hypertrophic rhinitis) is very common. It is frequently alternating in character, first one side and then the other being affected. It is most noticeable at night, when it causes mouth breathing and morning dryness of the throat. It should be treated by cauterization, or, in advanced cases, by removal of the anterior or posterior ends of the inferior turbinal. Complete turbinectomy is not to be advised.

Deviations of the Septum are readily recognized ; they may consist of displacements of the quadrilateral cartilage, or of curvatures in the bony septum as the result of injuries. The inferior turbinal on the concave side is generally hypertrophied. This condition is treated by what is known as submucous resection, the mucous membrane covering the septum being reflected, and the cartilaginous and the bony septum being excised.

Polypi are pedunculated swellings resulting from an œdematous condition of the mucous membrane of the middle turbinal, and their presence generally indicates a rarefying osteitis of the bone beneath, with, very often, suppuration in one or more of the accessory sinuses. They are recognized by their pearly-grey colour, their attachment to

the middle turbinal, and their free movement to the probe. They give rise to definite obstruction, and are associated with purulent or mucopurulent discharge ; but bleeding is not a symptom. They are generally multiple.

Removal of Polypi.—The region of the middle turbinal should be rendered anæsthetic by the application of a wool plug moistened with cocaine 10 per cent, 1 part, adrenalin chloride 1–1000, 1 part. This will cause the mucous membrane of the nose to shrink, and give a better view of the operation area. The cold wire snare should be used ; a simple and easily sterilized instrument should be chosen, and particularly one which works silently. Charles Heath's snare is well designed to meet these points, while Hovell's modification of Mackenzie's snare is the very reverse. The loop is passed along the floor of the nose, and then raised to encircle the polypus. If the end of the metal shank touches the front of the pedicle of the polypus, the snare is well applied. A gentle pull on the snare before tightening will show whether it surrounds the polypus. The loop is then tightened as high up on the pedicle as possible, and the polypus removed by pulling. Care must be taken not to cut the polypus off by drawing the loop too tightly, or the stump will be left. Be sure that the snare is carefully sterilized, and avoid using many instruments, such as polypus hooks, polypus forceps, and so on. In old patients, the removal of polypi is sometimes followed by brisk hæmorrhage : a point to be remembered, if it is proposed to do the operation in the out-patient room. No case of polypus should be operated upon until the condition of the sinuses has been investigated. There is a tendency for polypi to re-form, especially if there is definite ethmoiditis, and a more radical operation may be necessary, a description of which would be out of place in this book. Remember that a polypus placed far back may be visible only by posterior rhinoscopy. Do not make the common mistake of confusing enlargement of the anterior end of the inferior turbinal with a polypus. The two conditions are not in the least alike in position, in colour, in consistency, or in mobility, and yet the mistake is very common.

Foreign Body in Nose. — It has been well said that if a child has a unilateral nasal discharge, a foreign body should be suspected. Fortunately, the diagnosis is easily made, as the foreign body is generally but a short distance from the anterior nares. It is best removed by passing the spoon-shaped end of a director backwards along the nose above the level of the foreign body, until it has reached behind the object. The end of the spoon is then brought to the floor of the nose by tilting the outer end, and the foreign body is easily removed by steady traction. *No anæsthetic is required.* The use of forceps is not advised.

Nasal Discharges.—Purulent or mucopurulent discharges from the nose result from many causes. It is difficult to classify these, but the following list may be of service :—

PLATE IX

DR. BROWN KELLY'S METHOD FOR TRANSILLUMINATION OF THE ACCESSORY SINUSES OF THE NOSE

A.—Normal.

B.—Suppuration of right antrum Highmori

AGE	SITUATION	CAUSE
Before 3 months	Bilateral	Congenital syphilis
Childhood	Unilateral	Foreign body
	Bilateral	Adenoids Early atrophic rhinitis Acute infection—diphtheria, measles
Early adult life	Bilateral	Rhinitis Atrophic rhinitis
Adult life	Unilateral	Suppuration of antrum of Highmore Polypi and sinusitis Tertiary syphilis
	Bilateral	Rhinitis Polypi Sinusitis Tertiary syphilis
Old age	Unilateral	Malignant disease (rare)
	Bilateral	Polypi

Atrophic Rhinitis is sometimes associated with mucopurulent discharge, which readily dries and forms crusts. This process is accompanied by a penetrating odour to which the name ozæna has been given. The disease is one of early childhood, but is not generally brought for treatment till early adult life, and it is, therefore, very chronic and resistant to treatment. The odour, too, is so unpleasant, that the thorough treatment which is necessary for a cure is rarely applied. Treatment lies in the direction of removing crusts, applying antiseptic and stimulating treatment to the mucous membrane, and providing for adequate drainage. The condition of the sinuses should be investigated.

Suppuration in the Accessory Sinuses.—The sinuses are five in number on each side : the antrum of Highmore, the anterior and posterior ethmoidal cells, the frontal sinus, and the sphenoidal sinus. Suppuration in one of these is not generally limited to the sinus first affected. Thus, pus in the antrum of Highmore may have originated there, or may have drained into it from the frontal or ethmoidal cells ; the frontal sinus and anterior ethmoidal cells are frequently affected together, and the same is true of the sphenoidal and posterior ethmoidal. In all cases where the pus has an outlet it will appear in the middle meatus—that is to say, in the space between the inferior and middle turbinals—and in some cases the middle turbinal will be pushed towards the septum by a mass of granulations outside it. In the case of sphenoidal and posterior ethmoidal suppuration it may be possible by careful cleansing to prove that the pus has its origin above the middle turbinal, or it may be seen only on posterior rhinoscopy, as pus from this region has a tendency to pass backwards into the nasopharynx. The presence of pus is more readily detected in the antrum of Highmore than in the other sinuses. Two methods are generally adopted : (1) Transillumination ; and (2) Puncture.

Transillumination is a method whereby the cavities of the cheeks are lit up by placing a lighted electric lamp in the patient's mouth—observation taking place in a dark room. In a normal case not only the cheeks, but the orbital plate, and even the pupils of the eyes, will be illuminated, and the contrast between a sound and an affected side is pronounced. In doubtful cases the question whether the cheek is illuminated or not can be settled by drawing a finger firmly along the cheek. If the antrum is illuminated, the space just traversed by the finger will be found to be translucent. On the whole, transillumination is a valuable help to diagnosis, though one may be deceived in a case with very thick antral walls (*Plate IX*). (*N.B.*—Upper dental plates must be removed.)

Puncture is done through the nose under a local anæsthetic. The nose is first thoroughly irrigated to get rid of any pus which may be lying in the organ. A spot just below and behind the anterior end of the inferior turbinal is anæsthetized, and a trocar and cannula is driven backwards and outwards at an angle of about 45°, till it enters the antrum. The trocar is withdrawn, and the antrum irrigated with sterilized water. As the fluid escapes from the antrum, it is caught in a black papier-maché bowl, in which the pus, if present, shows plainly.

Transillumination has also been used for the *frontal sinus*, but with less success. Diagnosis by the passage of a frontal sinus catheter is not recommended for house surgeons.

Treatment.—The treatment of sinus suppuration requires very special skill in intranasal operations, and should not be undertaken by anyone without special training. It is essential that these cases should be referred to the special department for treatment.

Adenoids.—Hypertrophy of the adenoid tissue normally present in the roof of the nasopharynx (*Plate X*) occasions many troubles, some systemic, due to deficient oxygenation of the blood, others local, e.g., rhinitis, pharyngitis, and most ear troubles in children. The most constant symptoms of adenoids are : Snoring at night, mouth breathing, nasal tone of voice, morning cough, tendency to colds, earache, and deafness. Children with adenoids suffer frequently from bronchitis or bronchopneumonia. The adenoid mass is liable to follicular inflammation just as are tonsils, and this often gives rise to pyrexia in children. Children with adenoids do not make much progress at school, a fact which might be explained on the ground of partial deafness. Arithmetic seems to be their worst subject. Adenoid hypertrophy frequently co-exists with enlarged tonsils. The presence of adenoids should always be suspected in a child whose upper lip is excoriated by nasal discharge, in a case of recurrent earache, in a child with middle-ear catarrh, or in a backward child with undeveloped chest and morning cough. Diagnosis is easy by posterior rhinoscopy. Never make a digital examination if it can be avoided : it is clumsy, frightens the patient, and distresses the parents.

PLATE X

SECTION THROUGH THE NASAL FOSSÆ AND NASOPHARYNX TO SHOW THE POSITION OF THE ADENOID MASS

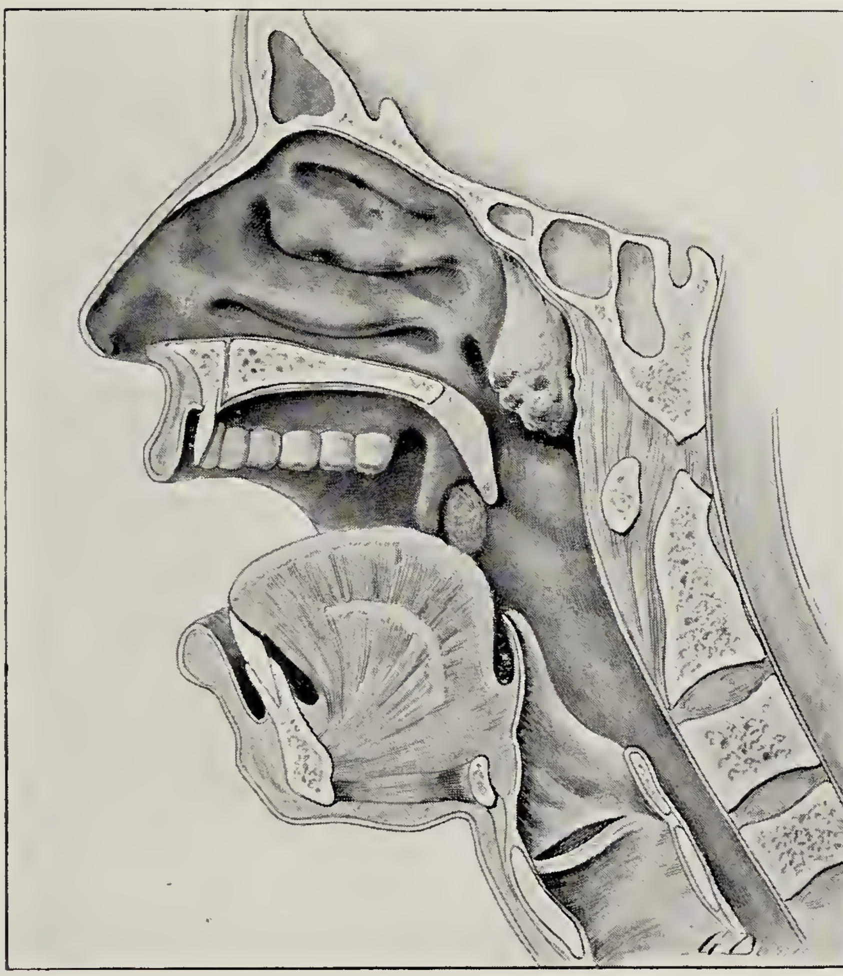
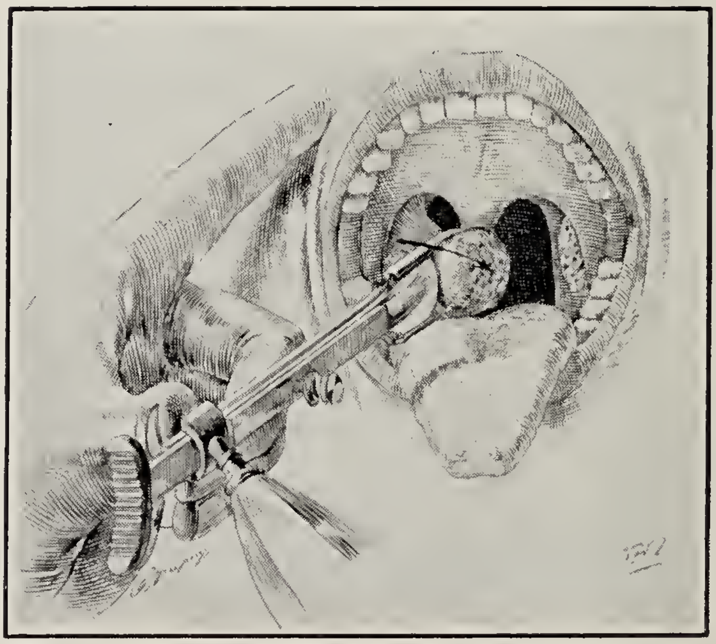


PLATE XI

ENUCLEATION OF THE TONSIL BY MEANS OF THE GUILLOTINE

A.—The tonsillotome being placed in position.



B.—The tonsil brought forward by the guillotine in the position for cutting off.

Treatment.—Of the many methods adopted by many surgeons for the removal of adenoids, the plan adopted by the writer will be alone considered. The anæsthetic is a matter of choice. The chloroform-ether mixture is excellent, ether is good if very well given, chloroform is perhaps a little risky, and if many cases have to be done, ethyl chloride is an admirable anæsthetic in competent hands. The patient lies on the back on the table, with a small pillow under the upper part of the shoulders. When anæsthetized, the head is over-extended, the upper part of the occiput resting on the table. The mouth is kept widely open by means of a Doyen's gag (*Fig.* 276), which is untouched throughout the operation. *A finger examines the growth*, and then a St. Clair Thomson's modification of Delstanche's caged curette (*Fig.* 277) is passed into the nasopharynx and moved upwards until the septum nasi is felt. The curette is then pressed firmly back, and the central mass of adenoids is removed by one firm sweep of the curette, the cutting blade of which should not travel more than half an inch. A Gottstein's curette is now rapidly used to remove any lateral masses, and the patient is then turned over on to the right side. A finger is passed into the nasopharynx, which should be found clear of growths. The tonsils are then removed, while the patient is on the side, with a guillotine (the simpler the better), the ring of the guillotine engaging the lower pole of the tonsil first, and being guided over the rest of the tonsil by the sense of touch. After the operation the patient is kept quiet for two hours. This method requires practice, but when the knack has been acquired it will be found to work excellently. The average actual operating time is fifty seconds, but there is no need of speed after the child has been turned on the side.

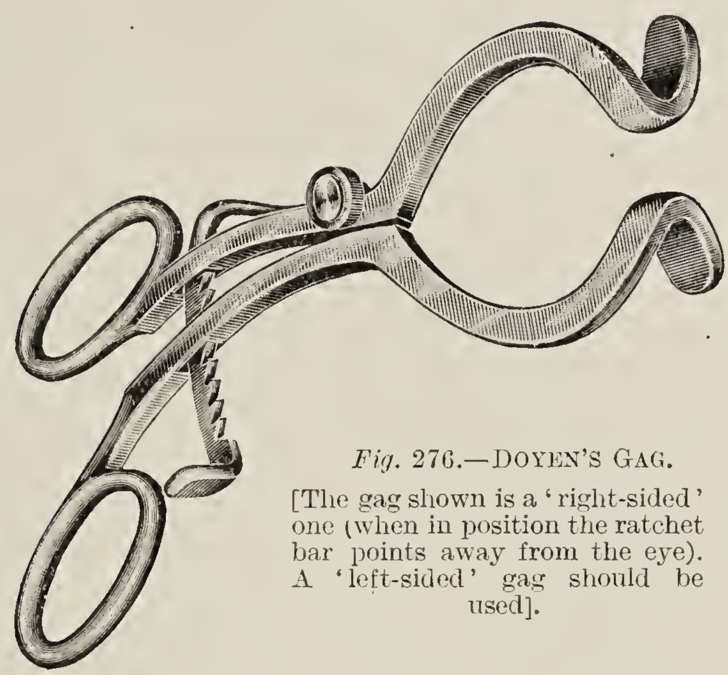


Fig. 276.—Doyen's Gag.

[The gag shown is a 'right-sided' one (when in position the ratchet bar points away from the eye). A 'left-sided' gag should be used].

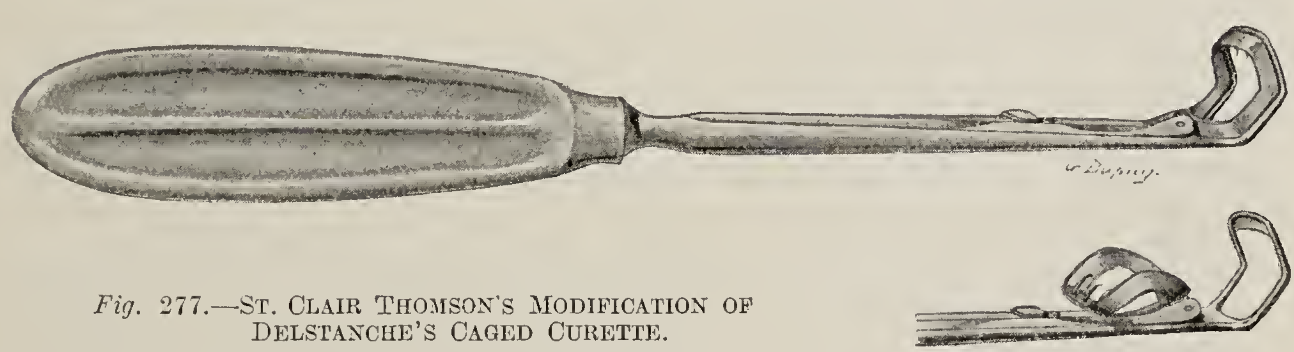


Fig. 277.—St. Clair Thomson's Modification of Delstanche's Caged Curette.

DISEASES OF THE PHARYNX.

Enlarged Tonsils.—As the result of repeated attacks of inflammation, or owing to a disposition to the growth of adenoid structures, the tonsils may become so large as to give rise to serious disability. They may become the subjects of 'lacunar tonsillitis,' where their crypts are filled with yellowish, putty-like plugs of inspissated secretion, or they may become frequently inflamed, and so on. Very often, indeed practically always in children, hypertrophy of the tonsils is associated with adenoid hypertrophy (q.v.).

Treatment.—If there be no adenoid enlargement in the nasopharynx, the tonsils may be removed by the guillotine under a local anæsthetic. If adenoids are present also, a general anæsthetic must be given. There is a point worth remembering in the choice of the tonsillotome. If a tonsil is flat and broad-based, the largest-sized tonsillotome should be used ; if the tonsils are large, prominent, and button-like, the smallest guillotine that will receive the tonsil is best.

Enucleation of Tonsils is an operation which perhaps will less often be performed by the house surgeon. It is employed in cases where it is necessary that the whole of the tonsil should be removed. A general anæsthetic is necessary. The mouth being kept open by Doyen's gag, under a good light the tonsil to be removed is seized with a volsellum forceps, and drawn well inwards. An incision is then made with a pair of scissors through the pharyngeal mucosa just above the tonsil (supratonsillar recess), and through this opening a finger or some blunt instrument is introduced and the tonsil separated from its bed of connective tissue. The separation is easy, and no force must be used. A few snips with the scissors free the tonsil from its attachments to the mucous membrane. In certain cases hæmorrhage may require treatment either by pressure or ligature.

Enucleation with the Guillotine (*Plate XI*).—This operation has been much used, but requires considerable practice. A general anæsthetic is needed. The mouth is kept open by Doyen's gag. A tonsillotome after the pattern of Mackenzie's, with a handle set at an obtuse angle, but made specially strong and *rather blunt*, is used. The free edge of the ring of the tonsillotome is placed below and behind the tonsil, with the knife blade outwards, and by means of firm pressure from behind forwards the tonsil is made to project beneath the anterior tonsillar pillar. The forefinger of the other hand then presses on the tonsil, forcing it from before backwards through the ring of the guillotine. The cutting blade is now pressed sufficiently far home to grip the tonsil (care must be taken to avoid cutting through the anterior pillar), which is levered out of its bed by rotating the handle in a half circle towards the patient's ear, the free edge of the ring of the guillotine acting as a fulcrum. The tonsil is brought well forward into the mouth, and is then cut off. The right side is easier to do than the left at first, and there is a tendency for the tonsil to slip back

through the ring of the guillotine during the rotation movement.

Though the greatest care is taken to be sure that all bleeding has ceased before the patient leaves the table, it happens sometimes that bleeding recurs a few hours later. There should be no delay in treating this. If necessary, an anæsthetic should be administered. The mouth is opened by means of a gag and the operative area examined with reflected light from a head mirror. Clots are removed and the raw surfaces closely scrutinized. Arterial bleeding is more difficult to see than venous, because it occurs as a fine spurt the origin of which may be obscure. An attempt should be made to seize the bleeding point with forceps and tie it with a catgut ligature. If this cannot be done, a small roll of gauze may be placed on the tonsil bed and retained in position under pressure by sewing the anterior and posterior tonsillar pillars together over it. This may be done either by a needle designed for the purpose or by Michel's clips. Self-retaining clamps have been devised, but should be used only if other means fail.

Quinsy (*Peritonsillar Abscess*).—Although the name 'quinsy' was formerly given to a condition known as 'parenchymatous tonsillitis,' the condition commonly seen in out-patient practice is not a tonsillitis at all, but rather an inflammation occurring in the cellular tissue forming the bed of the tonsil. Whether this inflammation is the result of extension from a deeply placed follicle of the tonsil, or whether it originates in the supratonsillar fossa, is a matter of small importance. If inflammation goes on to suppuration, an abscess forms behind and above the tonsil, and points in the region of the supratonsillar fossa, the anterior pillar bulging forward, and the tonsil itself being pushed inwards and slightly downwards. There is considerable constitutional disturbance ; the temperature may reach 103° or 104°, with headache, constipation, furred tongue, and foul breath. Swallowing is difficult, the mouth can hardly be opened, and the voice is reduced to a typical guttural whisper.

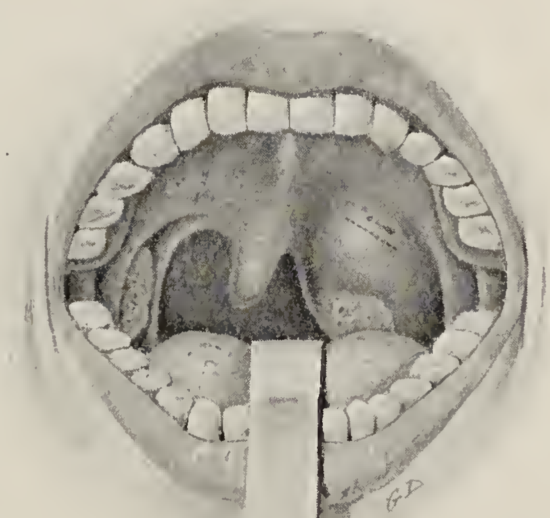


Fig. 278.—PERITONSILLAR ABSCESS. METHOD OF INCISION.

TREATMENT.—A brisk purge should be given, the patient confined to bed, and an incision made into the abscess. This must be done in the following manner : The tongue and lower jaw being depressed with a broad spatula (*Fig.* 278), a small keen scalpel is chosen, and, held on the flat with cutting edge inwards, is passed directly backwards into the outermost part of the swelling, about on a level with the base of the uvula, and therefore well above the tonsil. Having

entered the abseess eavity, the knife is earried inwards so as to make a horizontal ineision about ½ in. long. In making this incision some fibres of the palato-glossus musele are divided, so that the ineision gapes and good drainage is obtained subsequently. A pair of dressing foreeps is used to dilate the opening if the diseharge is not free. The advantages of this method are : (1) There is no danger of injuring any vessel of importanee, however deeply the knife is passed ; (2) If pus is present it is always struck ; and (3) Good drainage is provided. A preliminary applieation of eoeaine does nothing to relieve pain in these eonditions of aeutc eongestion, but it is useful as a plaeebo.

TRACHEOTOMY.

This operation, formerly a fairly eommon onc as performed for diphtheria, is now mueh more rarely required : first, because the use of antidiphtheritie serum has greatly redueed the severity of the attaek, and secondly, beeause intubation is being more used. On the question of intubation *versus* tracheotomy, mueh ean be said on either side. Intubation has the advantage of requiring no anæsthetie, it is quickly done, and it makes no open wound. Its disadvantages are that eonsiderable dexterity is necessary, the tube may beeome blocked by membrane, and it may be coughed out. It is a good operation in capable hands where a close wateh ean be kept on the patient, that is, in a hospital with a resident offieer. It is unsuitable for cases where the infection has spread into the trachea. There is no doubt that every house surgeon should have expcrience in traeheotomy, beeause it is eertain that on more than one oecasion he will be obliged when in private practice to open the traehea for dyspnœa when intubation instruments are not available.

Indications for Operation.—While tracheotomy may be required for the relief of asphyxia in many conditions, or as a preliminary step in eertain operations, diphtheria is the eommonest cause. Opinion is divided as to operating early or late. The general view now taken is that it is inadvisable to wait for cyanosis or signs of eireulatory difficulty. It is advisable to operate when inspiration is prolonged, expiration noisy, and the lower ribs are indrawn. It is urgent if a warm bath gives no relief, and espeeially if cyanosis, pallor, or a failing pulse be present.

Instruments Required.—In view of the fact that traeheotomy is an operation of urgency, it is a good rule to keep a complete set of the instruments required in one receptacle. This ensures that everything wanted will be at hand without delay. The following is the list :—

Two sealpels (in ease one is blunt)
Two pairs of disseeting forceps
Four pairs of Spencer Wells's pressure forceps
Straight seissors
Small-sized retraetors

Director
Tracheal dilator
Tracheotomy tubes (4 sizes)—Parker's
Needles, silk, silkworm gut
Tape, feathers.

Position.—The patient lies on his back with a pillow under his shoulders, the head being thus extended somewhat. He should be put in this position before the anæsthetic is commenced, and should not be moved afterwards, as the taking up of a new position in dyspnœa under anæsthesia may lead to a stoppage of the breathing. The anæsthetist stands at the head of the table, the assistant opposite the operator.

The Operation.—The operator should, with his left hand, define the larynx and cricoid cartilage ; then, lightly grasping the larynx with the thumb and second finger of the left hand, the index finger being placed in the middle line on the cricoid cartilage, a free incision is made from the cricoid downwards. This incision should divide the

279.—Tracheotomy. Opening the Trachea.

skin and superficial fascia. The middle line being again accurately determined, a further incision divides the deep fascia. If there is bleeding at this stage, the muscles in front of the trachea are rapidly scratched through or separated with the director, and the lateral muscular masses are seized with pressure forceps, which should be made to include as much as possible. These pressure forceps are allowed to hang down on either side, stop the bleeding, and act as retractors. If the isthmus of the thyroid gland is seen at this stage, it should be drawn downwards if in the way. The operator now steadies the larynx with his left hand as before, and enters the knife, edge upwards, into the trachea below the second ring, and carries it

firmly upwards, dividing the upper two rings but not the cricoid (*Fig.* 279). As a rule the opening of the trachea is followed by violent coughing by the patient. The tracheal retractors are at once inserted, and a short period is allowed to elapse during which the patient clears the trachea of blood and membrane. The outer part of the silver tube, armed with a 'pilot' if preferred, is then inserted into the trachea, and tied by tapes around the neck. The wound is partially closed by sutures, but drainage is provided for.

The operation is one requiring some nerve and a level head. It may be somewhat difficult in a small fat baby, with violent tracheal excursions and congested veins, or it may be extremely easy. There must be no hurry and no clumsiness. Every step must be done in order, and no effort made to open the trachea till its rings are exposed. A sharp hook is unnecessary, and may be the cause of cessation of respiration. It is much better to stop bleeding in the manner suggested, and quicker than picking up individual bleeding points, but if there is time, the veins may be picked up before they are cut. Open the trachea slowly and quietly. Once the trachea is open and the dilator in position, the object of the operation is obtained, and the introduction of the tube can be done at leisure. If respiration ceases before the trachea is opened, complete the opening and insert the dilators *before artificial respiration is started.* The passage of a feather into the trachea will often start respiration. Always pass the tracheotomy tube between the blades of the dilator: this will ensure that the tube shall be placed within the trachea.

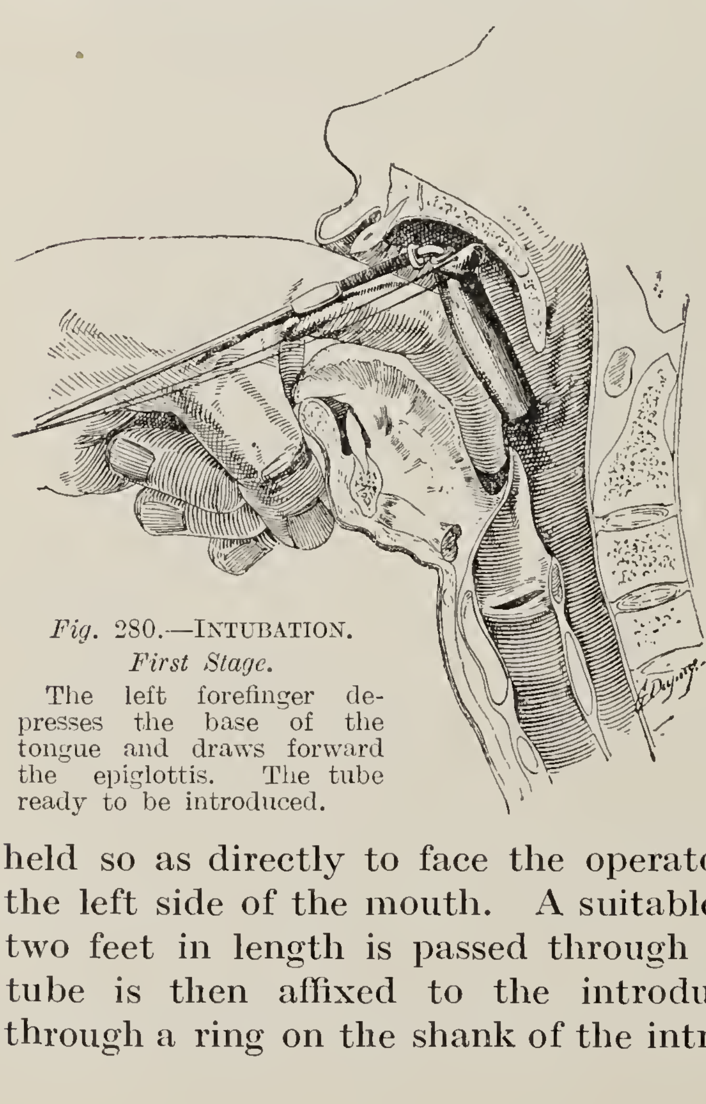


Fig. 280.—INTUBATION. *First Stage.*
The left forefinger depresses the base of the tongue and draws forward the epiglottis. The tube ready to be introduced.

INTUBATION OF THE LARYNX.

This operation requires special apparatus known as O'Dwyer's instruments. They consist of tubes of various sizes to fit the larynx, shaped with an upper flange which rests upon the false vocal cords, an introducer, an extractor, and a gag. No anæsthetic is required. The patient is placed in the sitting position, the head is held so as directly to face the operator, and a gag is introduced on the left side of the mouth. A suitable tube is chosen, a thread some two feet in length is passed through an eye in the flange, and the tube is then affixed to the introducer, the thread being passed through a ring on the shank of the introducer. The operator, holding

the introducer and thread in his right hand, passes his left forefinger into the patient's pharynx, identifies the epiglottis, and draws this and the root of the tongue forwards. The tube is then passed on the introducer along the side of the left forefinger (*Fig.* 280) until it reaches the posterior surface of the epiglottis. The handle of the introducer is then raised, and the lower end of the tube guided into the larynx (*Fig.* 281). When the tube is felt to be in the larynx, it is pushed boldly on between the cords until the flange rests on the false vocal cords. The left forefinger is then pressed on the upper end of the tube (*Fig.* 282) and the introducer removed. The thread should be retained, the free end being fastened to the cheek by strapping. By its presence extraction is made easy. If the thread is removed, the tube may be extracted at will by means of the extractor already mentioned.

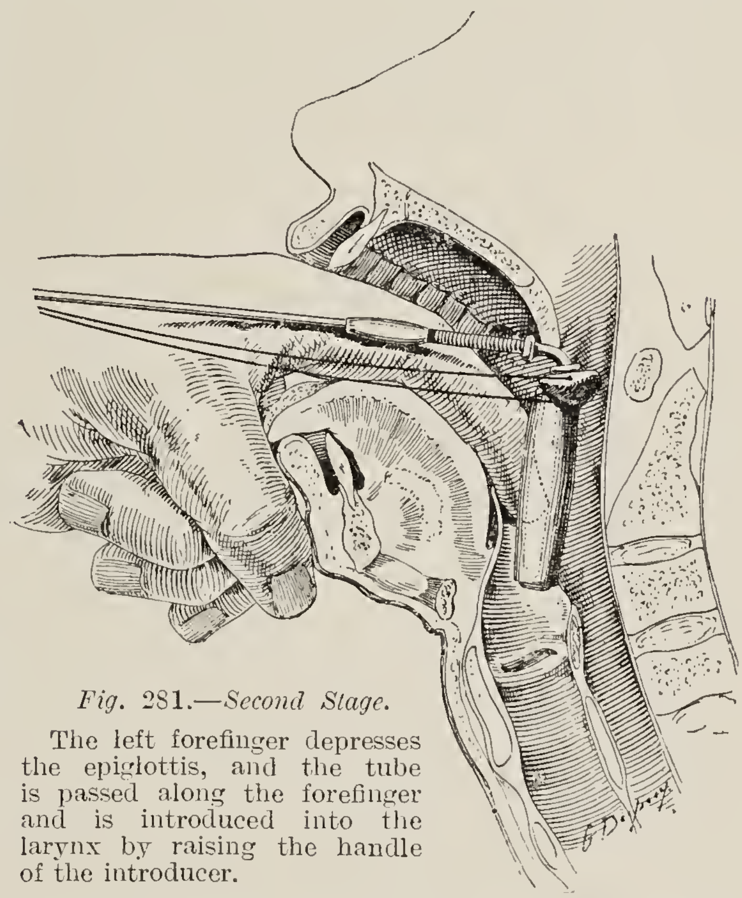


Fig. 281.—*Second Stage.*
The left forefinger depresses the epiglottis, and the tube is passed along the forefinger and is introduced into the larynx by raising the handle of the introducer.

The operation is one of great simplicity, once the knack is acquired, but considerable practice is needed. It is well to remember that the tube may push some of the membrane before it in its passage, and thus obstruct both the tube and the air-passage, so that tracheotomy instruments must always be ready whenever intubation is to be done for diphtheria. Again, the passage of the tube sometimes causes the breathing to stop, a result which may be guarded against either by cocainizing the larynx or by hypodermic injection of atropine.

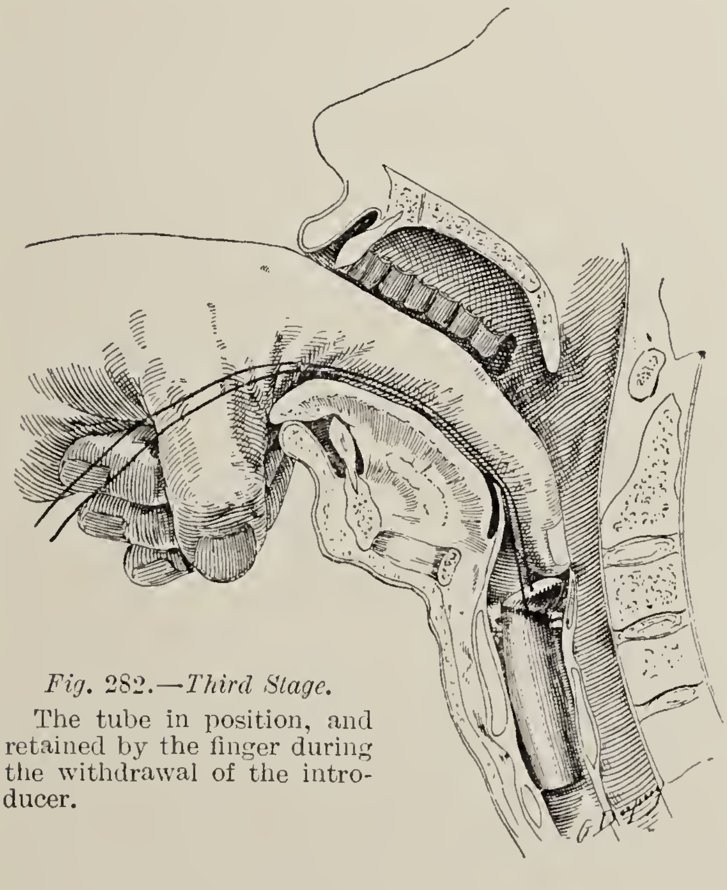


Fig. 282.—*Third Stage.*
The tube in position, and retained by the finger during the withdrawal of the introducer.

In some cases difficulty

is experienced in feeding patients who are wearing an intubation tube. This may be due to the use of a tube of too great a size, and in this case a change of tube will remedy the trouble. If this is not the cause, the patient should be fed lying on the back with the head below the level of the trunk, fluid food being administered by pouring it on to the palate from a spoon.

CHAPTER XLIII

COMMON DISEASES OF THE LARYNX

METHOD OF EXAMINATION.

THE larynx is examined by artificial light reflected from a head mirror in a manner similar to that adopted for examination of the nose, but the light is further reflected into the larynx from a small mirror (laryngeal mirror) fixed in a handle and held in front of the soft palate. The patient is told to breathe quietly throughout the examination, and to say 'ah' or 'ee' if desired. The head mirror having been so adjusted that the light can be focused directly on the patient's pharynx, a laryngeal mirror, the larger the better, is carefully warmed by holding it for a few seconds above the flame of a spirit-lamp. The patient is then directed to open his mouth and protrude the tongue as far as possible. A tongue cloth is laid on the fore part of the tongue, and the tongue is firmly held between the examiner's thumb (above) and middle finger (below) of the left hand, the forefinger being placed on the patient's upper lip to keep the moustache, if any, out of the way. The laryngeal mirror is now passed backwards till it touches the uvula, which is gently pressed upwards and backwards. The mirror then reflects a picture of the larynx, the epiglottis appearing in the upper part, the arytenoid cartilages in the lower, and the true and false vocal cords and the ventricles of the larynx in the centre (*Plate XII*). The patient is then requested to phonate, and thus the true vocal cords are more clearly seen, and their appearance and mobility can be studied. The examination requires some dexterity, as any clumsy movement may cause retching or straining. The points to be remembered are : (1) Use a large laryngeal mirror ; (2) Do not make the mirror too hot ; (3) Hold the tongue firmly, but do not pull ; (4) Pass the mirror back without touching the tongue or teeth ; (5) Do not make a prolonged examination. It is necessary to accustom oneself to holding the mirror in either hand.

FOREIGN BODY IN THE AIR-PASSAGES.

The accidental entrance of a foreign body into the air-passages is not very uncommon, but it is always a source of danger, and it may be almost immediately fatal. This is due to the fact that a foreign body, if impacted in the upper part of the larynx, will not only cause

more or less suffocation, but may also cause serious or even fatal collapse by reflex inhibitory action on the heart. The foreign body may lodge in various situations ; thus, sharp objects, such as pins or fishbones, if they pass the pharynx, generally lodge in the sinus pyriformis or else in the aryteno-epiglottic fold ; small round bodies frequently pass between the cords and reach the trachea or bronchus ; larger bodies become fixed in the upper part of the larynx or between the cords.

Symptoms.—If the foreign body be impacted in the **Upper Larynx,** it may cause sudden asphyxia and death by collapse. If the obstruction is not complete, violent inspiratory efforts and cough occur, with salivation, and perhaps vomiting, and in many cases the violence of the efforts is sufficient to expel the foreign body.

Treatment.—The foreign body can generally be removed by forceps or the finger. Inversion and succussion may be tried. If these methods are unsuccessful, no time should be wasted in further efforts, but laryngotomy should be performed. Laryngotomy is chosen instead of tracheotomy because it is easier and can be done more quickly. A vertical incision is made through the skin and subcutaneous tissue and fascia, and the larynx is opened by a horizontal incision through the crico-thyroid membrane, the incision being placed as near the cricoid cartilage as possible, to avoid injuring the crico-thyroid branch of the superior thyroid artery. Anæsthetics should not be given.

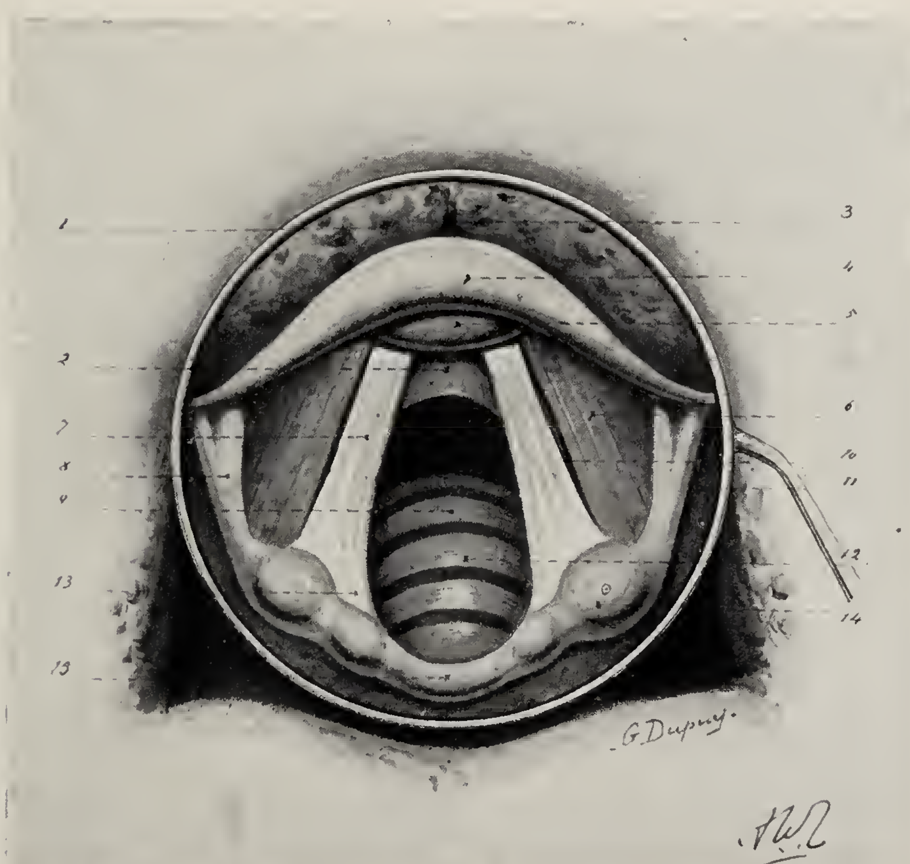
If the foreign body pass through the larynx into the **Trachea,** violent spasmodic cough is caused, the foreign body being driven against the under surface of the cord, and recurrent attacks of suffocation result. After a shorter or longer period the foreign body becomes less mobile owing to the excessive secretion of mucus, and the spasms may abate, to be renewed if the patient coughs or makes a sudden movement.

Treatment.—At one time the treatment of foreign body in the trachea consisted of the performance of a low tracheotomy and the searching for the foreign body—rather aimlessly, it is true—with forceps. With the discovery of the X rays, the search was made somewhat more easy ; but the greatest and most recent improvement in diagnosis and treatment followed the invention of the tracheo-bronchoscope by Killian, in 1897. The method of performing the examination was thus described by Killian. A 'tube spatula' (*Plate XIII,* A) is used which is widened in front and divided into two halves along its length, so that it can be easily removed from any tube introduced through it. A general anæsthetic should be given both to adults and children, and the patient placed with head hanging over the top of the table. The widened end of the tube spatula is passed over the middle of the tongue to its base, and placed between it and the epiglottis. By suitable pressure the interior of the larynx is exposed and brushed with 20 per cent cocaine. The point of the spatula is then passed

PLATE XII

LARYNGOSCOPY

A.—Examination by the laryngeal mirror.

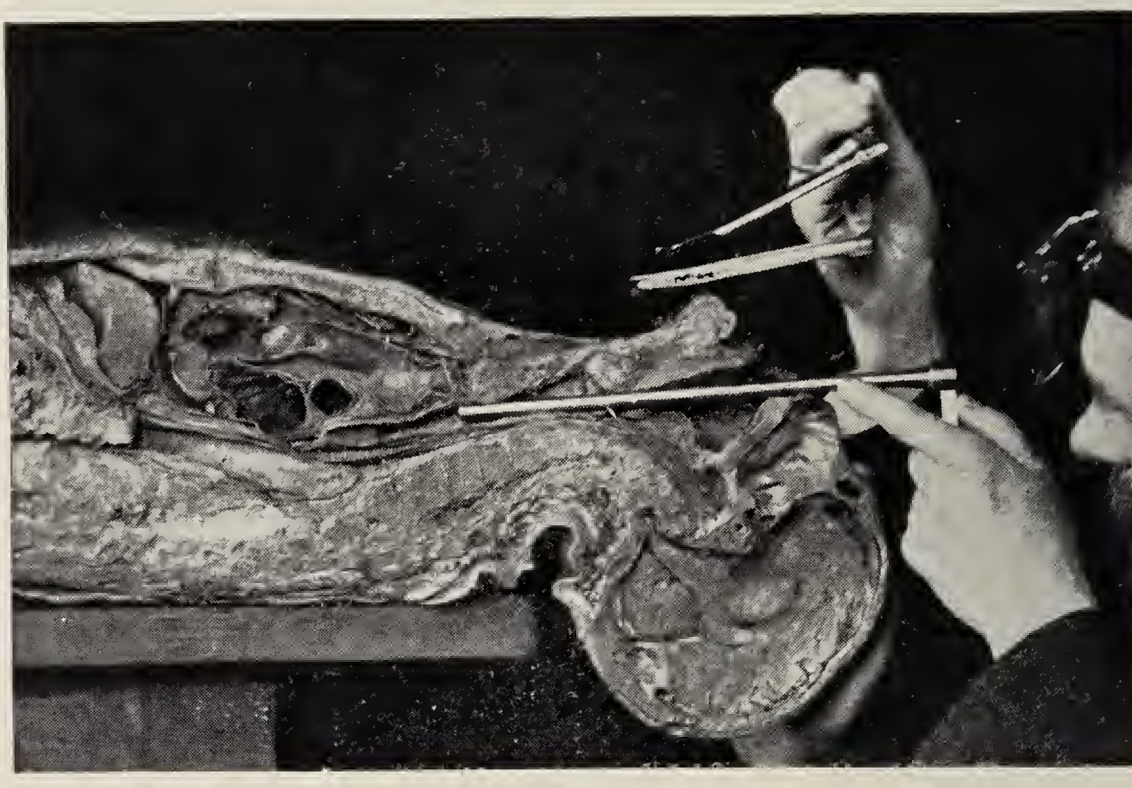


B.—Enlargement of the laryngeal image during inspiration, showing—

1. Base of tongue
2. Thyroid cartilage
3. Median glosso-epiglottidean fold
4. Epiglottis
5. Cushion of epiglottis
6. Ventricular band
7. True vocal cord
8. Aryteno-epiglottidean fold
9. Rima glottidis
10. Ventricle
11. Sinus pyriformis
12. Rings of trachea
13. Processus vocalis
14. Cartilage of Wrisberg
15. Inter-arytenoid space

PLATE XIII

BRONCHOSCOPY



A.—The tracheal tube having been introduced, the tube spatula, separated into its two pieces, is removed.

B.—Killian's bronchoscopy through a tracheotomy wound in the dorsal position.

By kind permission of Dr. P. Watson-Williams.

over the epiglottis, which is pulled upwards, and a view obtained into the trachea. A tube of suitable calibre is now chosen and passed through the tube spatula into the deeper parts for the examination of the lower trachea and larger bronchi, the spatula being removed. By the employment of specially designed hooks and forceps (Guisez) a foreign body can be readily removed through the examination tube. Illumination is provided by the Kirstein head lamp, but any powerful light may be reflected by means of a head mirror, and in recent types of instrument the light is carried in the tube, a much better arrangement. In some cases the tube may be passed through a low tracheotomy wound (lower bronchoscopy) (*Plate XIII*, B). Of these two methods, Killian preferred the former, but lower bronchoscopy may be used when urgent dyspnœa is present, when the lungs are affected and the bodily strength is reduced, or when the foreign body is large and irregular.

CATARRHAL LARYNGITIS.

This may occur as an acute or chronic manifestation.

Acute Catarrhal Laryngitis is an extremely common complaint, and many persons have a laryngeal attack whenever they have a 'cold.' It is probable that in these cases a slight chronic inflammatory condition exists, the 'cold' causing an exacerbation. Cold, sudden changes of temperature, and over-use of the voice are the common causes. Influenza is often complicated by laryngitis.

Symptoms.—The attack commences with irritation in the throat, leading to a dry cough. The voice is at once affected, and this hoarseness may in severe cases become a definite aphonia. A mucopurulent secretion follows, and there may be pyrexia and even a rigor. Swallowing is often painful.

In laryngoscopic examination the interior of the larynx looks much more red than usual, and the mucous membrane of the false vocal cords is swollen so as to prevent, in some cases, a view being obtained of the true cords. If these are seen, they will appear generally reddened and swollen, and their mobility may be somewhat impaired.

Diagnosis.—This is easy in adults, the fact that it is *never unilateral* differentiating it at once from many other laryngeal conditions. In children it may be confused with laryngismus stridulus or laryngeal diphtheria. From the former it is distinguished by its onset (fever, coryza) and by the persistent hoarseness ; from the latter. unless membrane be seen or coughed up, diagnosis is very difficult, but the facial appearance, the enlargement of the glands, and the albuminuria of diphtheria may make diagnosis possible.

Treatment.—In an uncomplicated case, treatment of a simple character will lead to early recovery. Rest to the voice is essential. Local applications by means of inhalations (tinct. benzoini co. or menthol vapour, 5 gr. to the ounce of parolein in an atomizer) are of value, or adrenalin chloride (1–5000) may be sprayed into the larynx.

An aperient should be given and the patient confined to bed. If the attack is of a more serious character, œdema of the glottis may supervene, and the patient may be suddenly in great danger. In such a case preparation should be made for tracheotomy, the low operation being preferred ; but much relief can be obtained by local punctures with Mackenzie's lancet, by spraying with equal parts of cocaine 10 per cent and adrenalin chloride 1–1000, the subcutaneous injection of pilocarpine, and the application of ice compresses.

Chronic Laryngitis may follow a neglected acute attack, but is more commonly due to over-use of the voice or to some condition causing constant irritation of the larynx, e.g., chronic rhinitis, pharyngitis, or some pulmonary affection leading to frequent coughing. In most cases of chronic laryngitis, the primary cause is in the nose, whether it be atrophic rhinitis, sinus trouble, or chronic hypertrophy of the nasal mucous membrane causing obstruction, and the posterior pharyngeal wall may be glazed with a thin layer of mucopus. It must not be forgotten that a simple laryngitis may occur in a patient with pulmonary tuberculosis. Hoarseness, and a loss of control of the voice, are the chief symptoms ; but associated with them are symptoms due to the causative lesion, e.g., nasal obstruction, morning cough, dryness of throat, mucopurulent expectoration, etc.

Laryngoscopic Examination.—The chief alteration in the appearance of the larynx is in the inter-arytenoid region, where, as the result of constant irritation, there is an overgrowth of the tissues (subepithelial) between and covering the arytenoid cartilages. In some cases this thickening (smooth, firm, opaque, white) may extend forward on to the posterior end of the vocal cords (pachydermia laryngis). In other cases the cords themselves may be chiefly affected, the changes consisting of thickening and irregularity, and in some cases distinct nodules form resembling minute papillomata. There is generally an increase of mucoid secretion, which can be seen on and between the cords and covering the inter-arytenoid space. Most of this comes from the nose and nasopharynx.

Treatment.—Any pathological condition of the upper respiratory tract must be treated Locally much may be done by rest to the voice and the application of sedatives or astringents, as the condition may require. In many cases of 'singer's nodes,' a form of chronic laryngitis due to over-use or misuse of the voice, an immediate improvement follows the correction of faults in voice-production and the use of Holbrook Curtis's exercises.

LARYNGEAL TUBERCULOSIS.

This is nearly always secondary to pulmonary tuberculosis, of which it is a common complication (30 per cent). It occurs most commonly in males between the ages of twenty and thirty, and is frequently unilateral in the early stages. It may be well to point out that a laryngeal affection occurring in a phthisical subject is not

necessarily tuberculous ; thus, a simple laryngitis is very common in phthisical patients ; and syphilitic lesions may occur. The first symptom is weakness of the voice, hardly amounting to hoarseness, with cough and expectoration. In some cases aphonia has been the first sign, and, occurring without any obvious lesion, has been diagnosed as 'hysterical aphonia.' As the disease advances, a whispering hoarseness becomes pronounced, and dysphagia occurs, associated with cough, hæmoptysis, night sweats, and wasting.

Laryngoscopic Examination.—There will be anæmia of the palate and fauces, though this may be only part of a general anæmia. The examination of the larynx may be very difficult owing to irritability and cough, and even when a good view is obtained the laryngeal mucous membrane may be covered with a milky-white secretion. There are three common forms of laryngeal tuberculosis : (1) Aryteno-epiglottic ; (2) Chorditic ; (3) Inter-arytenoid.

1. **Aryteno-epiglottic Tuberculosis** starts in the crico-arytenoid joint and extends along the aryteno-epiglottic fold. It is usually bilateral, forming two cushion-like masses on either side of the upper opening of the larynx. If the epiglottis is also affected, the clinical picture is typical and cannot be mistaken, as the only condition resembling it is œdema of the larynx. Ulceration is rare, but dysphagia common. If the epiglottis is little affected, the condition must be diagnosed from :—

Syphilis, which is generally unilateral and painless, with a tendency to ulcerate early.

Epithelioma, which is unilateral, dusky red, and leads to early impairment of mobility.

If the epiglottis is much affected, the condition must be diagnosed from :—

Syphilis, which affects the lingual surface rather than the laryngeal. If the epiglottis alone is affected, it is probably syphilitic, as tubercle affects the epiglottis late, and in association with arytenoid swelling.

Lupus, which affects the epiglottis only, occurring in characteristic red firm nodules, with the formation of scar tissue. It is rarely the only manifestation, the face, nose, or palate being often simultaneously affected. There is little pain, if any.

2. The **Chorditic** form is that in which the cords only are affected. At first a simple redness, differing from catarrhal laryngitis by being more marked on one side than the other, the condition advances till one cord presents the appearance of a band of granulation tissue, or a nodular mass. The condition affects the posterior half of the cord, a point of distinction from *syphilis*, which attacks the anterior half. If ulceration occurs, the syphilitic ulcer is much more sharply defined than the tuberculous, and has a hyperæmic edge and a flat base. The weak whispering hoarseness of tubercle is in marked contrast to the rough grating hoarseness of syphilis. From *cancer* the chorditic form differs in that a warty growth, common in cancer, is rare in tubercle ;

cancer is rare before the age of forty, affects one cord only, and causes early loss of mobility.

3. The **Inter-arytenoid** form occurs as soft semi-translucent granulations in the inter-arytenoid region, and if ulceration is present the condition is diagnostic of tubercle. It can only be mistaken for pachydermia laryngis (cf. 'Chronic Laryngitis'), but in pachydermia the outgrowths are whiter and firmer and more symmetrical.

Treatment.—But little can be said here on so large a subject as the treatment of tuberculous laryngitis, but a few general rules are appended.

1. In early cases before ulceration has occurred, treatment should be on ordinary sanatorium lines, with absolute silence.

2. If dysphagia is severe, relief may be obtained by curetting the arytenoid region or removing the epiglottis, but the propriety of active surgical interference depends upon the general condition of the patient.

3. If ulceration has occurred, and the general condition does not contra-indicate, great improvement may be expected from the frequent application of such drugs as lactic acid, carbolic acid, menthol, formalin, etc. The insufflation of orthoform is of value in dysphagia.

LARYNGEAL SYPHILIS.

This may come as a secondary or tertiary manifestation.

Secondary Syphilis affects the larynx a few weeks after infection, frequently existing at the same time as the rash. It consists of a hyperæmia of the mucous membrane and of the cords, occurring in patches resembling catarrhal laryngitis very closely.

Tertiary Syphilis occurs as a gummatous infiltration, with a tendency to break down and form typical syphilitic ulcerations. The epiglottis is the part most commonly affected, the ulceration attacking the lingual surface. If the cords are affected the anterior half is the seat of election, but in some rare cases syphilis may attack solely the inter-arytenoid region. The lesions run a typical course; ulceration is extensive and destructive, there is a tendency to the formation of dense scar tissue, and in intractable cases the cartilage of the larynx is itself affected. The crico-arytenoid joint may become ankylosed, leading to fixation of the affected cord, or the same result may follow the destruction of the muscles themselves, either by infiltration or nerve lesions.

Symptoms.—In the early stages hoarseness, cough, and perhaps slight respiratory difficulty will be the chief symptoms. The hoarseness is of a typical raucous nature, and is in itself almost diagnostic. Later, as the result of cicatrization, dyspnœa is the most important symptom, with hoarseness. There is little pain throughout, and the lesions may be surprisingly extensive and out of all proportion to the sufferings of the patient.

Treatment.—The treatment is on the lines laid down for syphilis

elsewhere; but if, as the result of scarring from the healing of gummatous ulcers, dyspnœa occurs, it may be necessary to perform tracheotomy—or, if possible, intubation.

NEW GROWTHS OF THE LARYNX.

While many forms of benign tumour may occur in the larynx, papilloma and fibroma are by far the most common.

Papillomata occur most commonly in children, and are multiple. They grow from the cords or the ventricular bands, and may form large cauliflower-like masses. They give rise to hoarseness, and in children to a characteristic cough; but dyspnœa is unusual.

Treatment.—An isolated papilloma should be removed by endo-laryngeal methods with forceps or curette. The multiple papillomata of children are best dealt with by thyrotomy, the growths being curetted or snipped away with scissors, but great care is necessary to prevent recurrence. For many years tracheotomy was advocated with a view to giving complete rest to the larynx, but is no longer advised by laryngologists. Removal by the endo-laryngeal method, assisted by Killian's tube-spatula, has given some good results, some such caustic as lactic acid being applied to the pedicles.

Fibromata are generally single, grow from the vocal cord, and occur in adults. They may be pedunculated or sessile. They give rise to hoarseness and, if pedunculated, to occasional aphonia. Dyspnœa occurs only if the growth is very large.

Treatment.—These growths must be removed by endo-laryngeal manipulations, and their removal should not be attempted by anyone not skilled in laryngeal work. The pedunculated are more easy to remove than the sessile, but either kind is sufficiently difficult.

Malignant Growths of the Larynx are much more rare than benign growths. They occur more commonly in men than in women, and are a disease of late life. They are classified clinically, according to their position, as *intrinsic* and *extrinsic*. *Intrinsic* tumours are those occurring within the laryngeal cartilages, e.g., growths of the cord, ventricular bands, ventricles, and the subglottic region; *extrinsic* tumours grow from the epiglottis, the ary-epiglottic folds, the inter-arytenoid space, and the pyriform sinuses. The distinction is important, as intrinsic growths increase very slowly and rarely disseminate or cause lymphatic involvement, while extrinsic growths are rapid in their development and metastasis is common enough. The lymphatics from the supraglottic region (the epiglottis, inter-arytenoid space, etc.) pass out through the thyro-hyoid membrane to a gland beneath the posterior belly of the digastric, and thence to the concatenate chain. The lymphatics from the subglottic region pass out through the cricothyroid membrane, or between the cricoid and the trachea laterally, and enter the chain of lymphatics round the internal jugular vein. From the interior of the larynx there is little lymphatic outflow, owing to the small amount of submucous tissue.

Carcinoma of the larynx occurs on one or other vocal cord in 50 per cent of cases. It begins as an elevated nodule, or as a warty growth, or rarely as an ulceration. Infiltration with œdema follows, and impairment of mobility is an early sign. Diagnosis is extremely difficult at an early stage, and every case of hoarseness due to thickening of one cord which resists treatment must be viewed with suspicion if occurring in a man over fifty. Pain is not generally complained of in intrinsic cancer, nor is the general health materially affected in the early stages. Dyspnœa occurs late if at all, though if glandular enlargement is present dyspnœa is probable towards the end. In extrinsic cancer, growth is much more rapid, there is a great deal of pain on swallowing, cough and mucopurulent expectoration occur, and cachexia supervenes early, due largely to the difficulty of swallowing. The pain is often referred to the ear on the affected side, a point to be remembered if an old man complains of earache and no ear symptoms are present.

Treatment.—In the early stage great success has attended the removal of intrinsic carcinoma by thyrotomy. Extrinsic growths and advanced intrinsic require complete removal of the affected part and the tissues wide of the disease, with the lymphatics of the region concerned. The operation of laryngectomy, whether partial or total, is a formidable measure, and can rarely be conducted on set lines.

Radium after removal of one ala of the thyroid is being used more and more in this disease, and has already proved its value.

NERVOUS AFFECTIONS OF THE LARYNX.

Functional Aphonia is not infrequently seen in girls of fifteen to eighteen years. The onset is sudden, the patient losing all vocal power except a thin whisper. There is no pain or discomfort as a rule. Frequently a history can be obtained of previous attacks, lasting perhaps for several months and resulting in a sudden spontaneous cure. Examination is generally easy, patients with this condition being very tolerant to laryngeal manipulation. The movements of the cords will be capricious—now quite free, now halting—and attempts to phonate will increase this. The very greatest care must be taken in diagnosis, which must be made by a process of exclusion. Particularly one must remember that an apparently causeless aphonia may be the first sign of tuberculous laryngitis, and the lungs must be carefully examined.

Treatment.—Brisk swabbing of the interior of the larynx with a small swab of wool on a holder, followed by an earnest attempt at speaking, will often result in cure. If this is not successful, the application of the interrupted current endo-laryngeally will generally be effective. The general health of the patient should be looked to, anæmia being very common in these cases.

PARALYSIS OF THE RECURRENT LARYNGEAL NERVE.

The recurrent laryngeal branch of the pneumogastric nerve supplies all the muscles of the larynx except the cricothyroid, ary-epiglottic, and thyro-epiglottic muscles, and the arytenoideus partly, and it is purely a motor nerve. On the *right* side the nerve arises in front of the first part of the subclavian artery. It hooks round the artery, passing below and then behind, and runs upwards and slightly inwards, crossing obliquely behind the common carotid artery. Reaching the side of the trachea, it runs upwards in the groove between the trachea and œsophagus with the inferior thyroid artery, and enters the larynx by passing under the lower border of the inferior constrictor of the pharynx. On the *left* side the nerve rises in front of the transverse part of the arch of the aorta, and winds round the arch just behind the obliterated ductus arteriosus. It passes obliquely behind the root of the left carotid artery to gain the groove between the trachea and œsophagus, where it follows a similar course to the right nerve.

Unilateral Paralysis.—The effect on the cord is a complete paralysis of abduction and of adduction. The cord lies in what is known as the 'cadaveric' position, i.e., midway between adduction and abduction. Paralysis is due, in the great majority of cases, to pressure on the vagus or on the recurrent nerve. On the left side the principal cause is an aneurysm of the arch of the aorta, on the right side subclavian aneurysm, or pleural thickening the result of tuberculosis of the apex of the lung. In addition, either nerve may be compressed by carcinoma of the œsophagus, goitre (innocent or malignant), mediastinal tumour, or glandular enlargements.

Symptoms.—There may be no symptoms whatever in a unilateral paralysis, the condition being discovered only on laryngeal examination. The voice is usually normal, but may be feeble or hoarse. Exertion may cause breathlessness, but there is not much interference with air entry as a rule.

Laryngoscopic Examination.—The affected cord is immobile, lying a little nearer the middle line than in normal respiration. The free border is concave. On phonation the unaffected cord is abducted, and generally crosses the middle line to meet the paralyzed cord, the arytenoid cartilage of the sound side passing in front of the other.

Treatment must be directed to the cause of the pressure, it being obvious that no local treatment is likely to avail so long as the causative lesion persists.

CHAPTER XLIV

COMMON COMPLAINTS OF THE EAR

THE examination of a case of disease of the ear must be conducted on very methodical lines, for it must be remembered that the great majority of ear complaints are secondary to pathological conditions of the nose or nasopharynx. It will not be sufficient, therefore, merely to examine the ear itself, but a routine examination must be made of the nose, nasopharynx, and throat as well. It is a good plan, in investigating an ear case, to examine the ear last, the order being nose, throat, nasopharynx, ear. In that way it is not possible to overlook a definite cause of the trouble which, untreated, would render all efforts at cure abortive. The patient must be placed in such a position that the ear is on a level with the eye of the examiner, a powerful lamp is placed slightly above and behind the patient's left shoulder, and the light is reflected on to the ear from a concave mirror fixed to the observer's forehead by a band of webbing (not elastic) or mounted on a spectacle frame. The observer should look through the hole in the centre of the mirror. A speculum is essential, and the surgeon should provide himself with various sizes, as an ill-fitting speculum seriously interferes with a satisfactory view. The aural part of the speculum may be round or oval, the latter being the more generally useful. Brunton's otoscope should not be used, as the light is more difficult to manage, and manipulations, such as swabbing out discharges, etc., are impossible. There is nothing to be gained by magnifying the field of examination. The surgeon should be supplied with a few cotton-wool holders (wooden 'spills' are best, the wool being twisted on to the previously moistened end so that a soft loose mop is made, rather like a minute feather broom), a pair of angular aural forceps, and a probe, bent so that the hand holding it is out of the line of sight. It is important to remember that even the slightest manipulation within the external meatus is a source of discomfort to the patient, and the most scrupulous gentleness must be observed, especially in children.

Diseases of the ear are readily divided into three classes : they may affect (1) The external ear ; (2) The middle ear ; (3) The internal ear.

DISEASES OF THE EXTERNAL EAR.

Cerumen.—One of the commonest causes of deafness is the over-secretion of cerumen by the glands lining the cartilaginous meatus. The glands exist in the outer third of the external meatus, and the

plug of cerumen is therefore generally near the orifice. So long as the plug does not entirely block up the meatus, the hearing is not impaired, but the wax readily swells if it becomes moist (e.g., from bathing), and deafness results. Patients will often give a history of sudden deafness coming on after a bath. If the plug has been in position a considerable time, a dermatitis may result and epithelial débris is added to the mass, but impaction of cerumen does not tend to cause middle-ear disease, though in some cases of prolonged impaction the membrana tympani looks thickened. The plug does not generally extend as far as the membrana tympani. As impaction of cerumen is occasionally associated with adhesive proeesses in the middle ear, it is well not to give a favourable prognosis until the wax has been removed and the ear examined.

Treatment.—In the majority of cases the wax can be easily removed by syringing. A large syringe with a long narrow nozzle should be used, the pinna should be gently drawn backwards and upwards to straighten the meatus, and a stream of warm water directed along the roof of the meatus. If the wax is very hard, it may be at once softened by instilling a few drops of peroxide of hydrogen into the meatus. In two or three minutes the plug may be washed out. If peroxide of hydrogen be used it will never be necessary to remove the wax by instrumental means.

Foreign Bodies.—The diagnosis of a foreign body is a simple matter if a careful examination be made with a good light. It is rarely deeply placed in the meatus unless unsuccessful efforts have been made to remove it. The only condition with which it is possible to confound it is impaction of cerumen. A touch with the probe will settle the diagnosis. Efforts must be made to remove these foreign bodies by syringing. This method is nearly always successful, but if it fails, the patient, if a child, *must be anæsthetized* before any effort is made to remove it by instruments. The best form of instrument is a bent probe or an incus hook, which should be passed on the flat beyond the foreign body, turned through 90°, and withdrawn. It is not advisable to try to withdraw a foreign body with forceps; this rarely succeeds, and often the offending matter is pushed in farther. In rare cases it may be necessary to remove the foreign body through an incision behind the ear, the cartilaginous meatus being incised after drawing forward the pinna. This should not be done in the out-patient department.

Furunculosis.—A follicular inflammation originating in a sweat gland or hair folliclc occasionally oecurs in the external meatus. From the nature of its origin it is confined to the outer third of the meatus. It may occur without ascertainable cause or during the course of a middle-ear suppuration, or in eczema of the meatus. The first symptom is that of severe pain in the ear, radiating to the side of the head and face. The pain is aggravated by touching the pinna or by moving the lower jaw. A swelling follows, obliterating the

furrow between the pinna and the mastoid, and extending on to the mastoid, simulating suppuration in the mastoid process. In some cases there is swelling in front of the ear also. It is very important that this condition should be differentiated from mastoid disease. The following are the principal points of difference :—

1. A furuncle gives rise to much more pain and tenderness than mastoid disease.

2. The furuncle gives rise to early swelling and often to pre-auricular glandular enlargement ; in mastoid disease, swelling is late or absent, and the pre-auricular glands are not affected.

Fig. 283.—Posterior View of a Case of Mastoid Disease. Note furrow between mastoid and ear, and compare with *Fig.* 284.

Fig. 284.—Case of Meatal Furunculosis. Note loss of furrow between mastoid and ear, and compare with *Fig.* 283.

3. If there be mastoid swelling, it tends, in the case of a furuncle, to be diffuse and to obliterate the furrow between the auricle and the mastoid, while in mastoid disease the swelling is more circumscribed and the furrow persists (*Figs.* 283, 284).

4. The furuncle is *always* placed in the external half of the meatus, and is therefore never so deep, never so near the membrane, as the drooping of the meatal wall so characteristic of mastoid disease. The furuncle is not confined to the posterior superior quadrant, and may be multiple.

5. Furunculosis rarely, except in children, causes rise of temperature.

Treatment consists in incision through the furuncle, followed by hot fomentations, and the use of boracic lotion and peroxide of hydrogen locally. A brisk purge should be given.

MIDDLE-EAR DISEASES.

The middle-ear disease most commonly met with is a catarrh, leading to thickening of the lining membrane of the middle ear and interference with the movements of the ossicles, or, if sepsis has occurred, to suppuration. In both conditions it must be understood

that the middle ear is not primarily at fault, but that the catarrhal condition has extended from a disordered nasopharynx by way of the Eustachian tube. It is obvious, therefore, that in treating middle-ear trouble the nose, throat, and nasopharynx must be thoroughly examined, and any abnormality corrected as the first step in the cure.

Subacute Middle-ear Catarrh.—This condition is very commonly met with in out-patient departments, and is responsible for the great majority of cases of earache. The symptoms are a sense of fullness or actual pain in the ear, accompanied by more or less deafness. The membrana tympani loses its lustrous appearance, and may look dark-grey, or reddish if the catarrh is acute. Occasionally a definite inflammatory condition of the membrana tympani is present (myringitis). Owing to retraction of the membrane, the cone of light is shortened, but is seldom absent. The handle of the malleus shows plainly through the membrane, the short process seeming to press through the upper part. A prominent fold, concave anteriorly, may be seen passing down from the short process along the posterior edge of the membrane. In cases where there is a serous exudation in the middle ear, it may be possible to recognize the level of the fluid as a concave line across the membrane. Treatment must be directed to the relief of the causal condition. In the great majority of cases of recurrent earache in children adenoids are present, in other cases catarrhal rhinitis and pharyngitis. The introduction of air into the middle ear generally gives immediate relief.

Chronic Non-suppurative Middle-ear Catarrh. — This condition results from neglected or inadequately treated catarrhal conditions, and is always dependent on some disorder of the nose, throat, or nasopharynx. It produces a form of obstructive deafness which is very resistant to treatment, though the chance of success depends almost entirely on the duration of the disorder. The symptoms are deafness and, in many cases, noises in the head. The external meatus is generally wide, and free from cerumen, thus permitting a clear view of the membrana tympani. The membrane is indrawn, thickened, and its movement, when tested by Siegle's pneumatic speculum, is markedly deficient The handle of the malleus and the short process are prominent, the posterior fold (described above under 'Subacute Catarrh') is present, and the cone of light is shortened, distorted, or absent. The deafness is of the middle-ear type, i.e., deafness due to defect of the sound-conducting apparatus, not of the sound-perceiving (auditory nerve) apparatus. It conforms to the following tests :—

1. *The perception of sound through the air* (*air-conduction*) *is diminished.* This is usually tested with a watch, or an apparatus designed to give a sound of definite intensity (acoumeter) may be used.

2. *The perception of sound through the cranial bones* (*bone-conduction*) *is increased* (Rinné's test).—A vibrating tuning-folk is held close to the ear, and when the patient can no longer hear it, the plate of the

fork is applied to the mastoid process. The sound will then be again perceived by the patient for a varying period.

3. If the plate of a vibrating tuning-fork be applied to the vertex in the middle line, the sound will be heard better in the affected ear (Weber's test).

4. Hearing for high notes is not much affected.

For the sake of comparison, the points of difference between middle-ear deafness and internal-ear (nerve) deafness may be summarized in parallel columns.

Middle-Ear Deafness.	Nerve Deafness.
1. May occur at any age.	1. If not following some definite illness, patient probably old.
2. History of gradual onset associated with nose or throat troubles.	2. In young or in middle-aged patients, probably following upon syphilis or influenza.
3. Nose, throat, or nasopharynx shows signs of chronic disorder.	3. Nose, throat, and nasopharynx normal.
4. External meatus wide and free from cerumen.	4. External meatus normal.
5. Membrana tympani altered in curvature, consistency, or mobility.	5. Unless middle-ear catarrh coexist, membrana tympani normal.
6. Perception of low notes is impaired, of high notes maintained.	6. Diminished perception of high notes.
7. Bone-conduction (increased) is greater than air-conduction (diminished).	7. Bone-conduction (diminished) is less than air-conduction (diminished).
8. Inflation through Eustachian catheter may show obstruction.	8. No Eustachian obstruction.

Treatment.—This must be directed primarily to the cure of the causative factor, which will be found in the nose, throat, or nasopharynx. Local treatment consists in restoring and maintaining the patency of the Eustachian tube, and in improving the mobility of the membrana tympani and the ossicles by some form of massage. This may be administered either by inflating the middle ear with air or medicated vapour through the Eustachian tube, or by alternate rarefaction and condensation of the air in the external meatus. The latter method is achieved by an instrument which, by means of regulating the length and frequency of a piston stroke, can be made to rarefy and condense at will the air in the external meatus. Its easy application is perhaps its chief recommendation.

Inflation of the middle ear must always be done by catheter if the patient is old enough to permit of the passage of the instrument. The method of inflation by Politzer's bag should be given up for several reasons: First, it is quite ineffectual except in early deafness due to Eustachian catarrh; second, it does not allow of the admission of vapours into the middle ear; third, its effects cannot be limited to the affected ear. It is obvious that the inflation of the sound ear when treating a unilateral affection is an entirely unjustifiable proceeding. The use of Politzer's bag, then, should be reserved for children, upon whom it may be impossible to pass a catheter.

The Passage of a Eustachian Catheter.—It is a good plan to cocainize the patient's nose on the affected side by placing along the floor a pledget of wool moistened with a 2 per cent solution of cocaine. The patient sits facing the operator, the chin and face slightly depressed. The patient's ear must be connected with that of the operator by a rubber tube having bone terminals for fixing in the external meatus. This is absolutely necessary if the operator wishes to know the results of the inflation. The catheter, carefully sterilized, is held by the big end, and the small end is placed on the floor of the nose and rapidly and *smoothly* passed backwards until the posterior pharyngeal wall is reached. The catheter is then slowly withdrawn for about half an inch, slight pressure being used to rotate the point outwards. The point will be felt to pass over the posterior lip of the pharyngeal orifice of the Eustachian tube and slip into a position directed outwards and a little upwards. The ring on the big end points in the direction of the small end. The point is in the Eustachian orifice if the catheter cannot be drawn further forward. When in position, the ring and the large end are held between the thumb and forefinger of the left hand. The nozzle of an inflation bag is inserted into the catheter, and air is introduced. To prevent 'dragging,' the inflation bag should be hung to a coat button and should have a long tube. Medicated vapours or sprays may be introduced by using an atomizer connected with a compressed-air cylinder instead of the inflation bag, or by placing a drop or two of the required solution in the wide end of the catheter before inserting the nozzle.

Middle-ear Suppuration.—This form of disease of the ear is very common, and is only too frequently looked upon as an unpleasant and offensive condition which can be best disposed of by ordering a lotion to be syringed into the ear. The subject is too large to be adequately discussed here, but a few hints on the management of the cases and the recognition of complications may be useful.

1. Speaking in general terms, a discharge from the ear indicates middle-ear suppuration with a perforation of the membrana tympani.

2. The external meatus must be *mopped dry* with small cotton-wool swabs before examination.

3. Occasional bleeding from a discharging ear indicates the presence of granulations.

4. The size and situation of the perforation must be noted.

5. Discharges which cease and recur at intervals should make one suspect the presence of adenoids in children.

6. Always examine the nose, throat, and nasopharynx

7. Granulations (polypi) grow from the middle ear through the perforation : a probe passed round them finds no point of attachment.

8. Bacteriological examination of the discharge shows that a pure culture (generally *Staphylococcus aureus*) is rare. The *Bacillus coli communis* is common enough in mixed cultures, and causes offensive discharges which are very resistant to treatment.

9. Children with offensive discharges from the ears frequently have carious teeth.

10. Narrowing of the meatus or sagging of the posterior superior quadrant of the meatal wall makes one suspect mastoid disease in prolonged suppuration (for differential diagnosis between furunculosis and mastoid disease, *see* p. 474).

Treatment of Middle-ear Suppuration.—First treat any pathological condition of the nose or nasopharynx, such as rhinitis or adenoids, which, if left untreated, would render local treatment useless. See to the patient's general health, particularly looking out for anæmia. Local treatment consists in obtaining free drainage of the middle ear and introducing antiseptics to combat the suppuration.

Free drainage is essential. It is for this reason that it is necessary to note the size and position of the perforation. In *acute* middle-ear suppuration before perforation, an opening must be made in the membrana tympani, and this opening *must be free* and in a dependent part. To make a small incision is merely to inflict pain without a compensatory advantage. In more *chronic* cases, the perforation, if too small for adequate drainage, must be enlarged.

In ordering lotions for syringing, it must be remembered that a lotion syringed into the meatus by unskilled hands does not reach the middle ear, and therefore treatment by lotions is not enough. They do, however, remove the discharge lying in the external meatus, and are therefore of value as a preliminary to other treatment ; but it is not necessary to order lotions of high bactericidal properties, nor is it advisable to give out-patients highly poisonous lotions. Antiseptic powders should not be ordered to be blown into the ear, as out-patients in their zeal use too much, and there is a risk of 'caking' and consequent interference with drainage. It is best to order a lotion to be gently run into the meatus to remove the discharge, followed by a few drops of a spirituous solution. Rectified spirit, if slightly diluted, is a powerful antiseptic, and will penetrate through the perforation. As it evaporates it leaves the antiseptic behind which had been dissolved in it. Such spirituous solutions are :—

℞	Rectified spirit (10 per cent, 25 per cent, 50 per cent, 75 per cent)	
℞	Boric acid	gr. x
	Rectified spirit (in various percentages)	℥j
℞	Argyrol	gr. ij
	Rectified spirit (in various percentages)	℥j

Peroxide of hydrogen is a valuable application, having the advantage that it is painless (which cannot be said of rectified spirit) and also a powerful antiseptic. The discharge must be carefully removed before this is instilled, or a foam is formed which will prevent the peroxide reaching the middle ear.

If a chronic middle-ear suppuration does not yield to treatment carried on for, say, six months, and especially if granulations recur

after removal, it is probable that the attic or the mastoid antrum is involved, and the question of the advisability of a radical operation must be considered.

Complications of Middle-ear Suppuration.

Mastoid Disease generally occurs in cases of prolonged suppuration, but it may arise early in some cases, e.g., after influenza or measles, or it may be the first sign of ear disease in tuberculous mastoiditis, the onset of which is very insidious. It is characterized by the occurrence of *pain*, starting in the ear or the mastoid process, and tending to radiate over the side of the head, *local tenderness and heat* (by no means constant), *pyrexia*, *malaise*, and in some cases *giddiness and nausea.* The discharge may cease from time to time, this being the signal for the occurrence of symptoms which pass away when discharge recurs. We must not expect to find any mastoid swelling in the majority of cases. When it is present the disease is far advanced. The swelling is limited to the mastoid, and only in the late stages does the groove between the mastoid and the pinna become obliterated. Through the speculum, the external meatus is found to be narrowed by the drooping of the posterior superior quadrant near the membrane, and granulations may be present. The differential diagnosis between mastoid disease and furunculosis, which is most important, is fully described on p. 474.

After-treatment of Mastoid Operations.—In the acute form the antrum will be drained from behind the ear ; in chronic cases drainage will be arranged for through the posterior wall of the meatus. As a rule, the cavity of the antrum is packed with ribbon gauze, and the dressing consists in removing this, cleansing the cavity, and replacing the packing. The dressing is painful, and must therefore be done very delicately and carefully. The first dressing is generally done on the second day, though the time varies according to the condition found at the operation. The operation should have been so planned that the whole of the cavity of the antrum and middle ear can be inspected. The original gauze packing is moistened with peroxide of hydrogen, and can then be withdrawn with but slight pain. The cavity is then inspected through a large-sized speculum by means of reflected light, and cleansed either by mopping out or syringing. The packing is then replaced through the speculum, the greatest care being taken to pack the gauze lightly but evenly into the cavity. After the first dressing, the packing should be removed and replaced daily, the patient being allowed out of bed at the end of a week if all is well. When the cavity is covered by granulations, it may with advantage be painted occasionally with some stimulating preparation such as a saturated solution of iodoform in ether, or lotio rubra, to aid in the epithelialization of the cavity if grafting has not been employed. The patient may be discharged in about a fortnight.

Lateral Sinus Thrombosis gives rise to a train of symptoms which

is very characteristie. The patient is obviously very ill. Headache and vomiting are early and well marked. The temperature rises rapidly to 104° or 105°, with fluctuations of a remittent type. The pulse is small, rapid, and thready. Rigors occur early, are often repeated, and increase in frequency as the case proeeeds. The tongue is dry and coated, and the breath foul. There may be mastoid swelling, which, if it oecur over the mastoid emissary vein, is very signifieant. Pressure over the upper part of the internal jugular vein causes pain, and the vein may be felt to be thrombosed.

After-treatment of Lateral Sinus Operations.—It is the usual practice to tie the internal jugular vein at the time of operation, and the greatest care must be taken to prevent the incision beeoming infected from the septic wound above. It is a good plan, if the patient is a child, to do the first dressing under a general anæsthetic, as the removal of the packing in the lateral sinus groove and its replacement are done with more accuracy if the patient is still. The general treatment is on the lines laid down for septieæmia.

Abscess of the Brain.—This may oecur either in the eerebellum or in the temporosphenoidal lobe, as the result of mastoid disease. Both cerebral and cerebellar abscesses have eertain symptoms in eommon. These are : fixed headaehe ; slow cerebration ; normal or subnormal temperature, the temperature being raised on the opposite side of the body if the lesion is situated in the eoronal plane through the Rolandic area (Victor Horsley) ; slow regular full pulse, and slow respiration; and, later on, marked emaciation. (Aeute abseess differs in some respeets from this elinical pieture.) In either, vomiting and optic neuritis may oceur, though neither sign is eonstant. Optic neuritis, if double, and equal on both sides, points to meningitis rather than abseess. In abscess, the optic neuritis affeets first the upper part of the disc of the affected side.

In *temporosphenoidal abscess* there may be paralysis of the opposite side owing to pressure on the Rolandic area aeross the fissure of Sylvius, affeeting the faee first, and then the arm, the leg generally escaping. If on the left side, aphasia may oeeur. The 3rd nerve on the side of the lesion may be paralyzed, leading to dilatation and immobility of the pupil on the same side. In abseess, the superficial reflexes, if affected at all, are affected unilaterally and disappear slowly. The abdominal reflexes are affeeted sooner than the knee-jerk, and therefore are more important diagnostieally.

In *cerebellar* abscess there may be muscular rigidity affecting the limbs of the same side ; conjugate deviation of the eyes to the other side ; nystagmus, lateral or rotatory according as the abscess is in the lateral or central lobe ; exaggerated knee-jerks on the same side ; and vertigo, with a tendeney to fall towards the side opposite the lesion. Patients lie curled up on the side opposite the lesion in cerebellar, but on the side of the lesion in cerebral, abseess.

CHAPTER XLV

THE TREATMENT OF THE TEETH

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THE treatment of the teeth is a special branch of surgery practised by dental surgeons, and the preservation of the teeth by conservative treatment is not usually attempted by medical men ; but the general practitioner in country places, and the surgeon in the army or navy, are frequently called upon to relieve pain caused by the teeth, either by palliative measures or extraction. Furthermore, it becomes the duty of the family doctor to advise parents as to the care of children's teeth, and the means of preventing the ravages of decay and loss of valuable permanent teeth, unfortunately so prevalent at quite an early age.

It becomes necessary, therefore, that the medical man should know something of the hygiene of the mouth and of the evils arising from needless extraction of the teeth, especially during childhood ; that he should be able to diagnose the seat of dental pain and afford temporary relief whenever possible, with a view to subsequent treatment by a dental surgeon ; and that finally, as a last resource, he should be able to extract a diseased tooth or root expeditiously, though deliberately, with a minimum of pain to the patient and of damage to the surrounding tissues. The scope of this manual will only permit of oral hygiene being dealt with very briefly, but the details of diagnosis will be considered at some length, and the use of the dental forceps will be fully described.

Dental caries is especially a disease of childhood and early adolescence, and it is by no means unusual for the temporary molars to be seriously affected, or even rendered useless, before the first permanent molars commence to erupt behind the temporary molars during the seventh year. Dental caries is also a locally infective disease ; and it consequently follows that the first permanent molars, which should be the chief organs of mastication between the ages of seven and twelve, are soon hopelessly decayed, and possibly the cause of abscesses or sinuses. In a healthy mouth, the natural replacement of the temporary dentition by the permanent takes place in such a way that the child is adequately provided with organs of mastication during the years when assimilation and growth are most rapid. But

when this process is interfered with by disease, and consequently by premature loss or undue retention of temporary teeth or roots, several evil results follow : painful or tender teeth prevent proper mastication, septic conditions of the mouth cause ill health and malnutrition, extraction of the temporary teeth entirely deprives the child of the organs of mastication, and interference with the normal sequence of events causes irregularity and crowding of the teeth of the permanent dentition. If the first permanent molars become carious, as so frequently happens, and have to be extracted, the necessary stimulus to the growth of the jaws afforded by use is removed, and small jaws with narrow arches may result.

Correct diet, preventive treatment, and hygienic measures will very greatly diminish the incidence of dental caries in childhood, and palliative treatment will serve to allay pain until such time as conservative treatment can be undertaken by a dental surgeon ; but in spite of the developmental irregularities occasioned by early loss of the temporary teeth and first permanent molars, whenever these teeth are so far carious as to interfere with mastication, or cause abscesses or sinuses, or a general septic condition of the mouth, they should undoubtedly be removed. Carious temporary teeth and first permanent molars are a fruitful source of enlarged submaxillary glands which may ultimately be the seat of tuberculous infection, and septic mouths are the prime origin of many of the ills of childhood ; there can be no doubt in such cases that of two evils extraction is by far the less. It is surprising how children improve in health after the removal of septic teeth and roots, even if the masticating power is insufficient, provided the diet is adapted to the conditions.

In the case of the permanent dentition, it is now generally recognized that a sound set of teeth is a very valuable asset to their possessor throughout life, and the ruthless extraction of teeth that could be saved by a pleasanter and less heroic method is greatly to be deprecated.

Teeth which are the seat of active caries must be distinguished from those affected by two different conditions, namely, hypoplasia of enamel and arrested caries. The former condition is characterized by deficiency and discoloration of the enamel, and unevenness of the surface in the form of pits and transverse lines. The more common variety, in which the coronal surfaces of the first molars and the edges of the central incisors have deficient or pitted enamel, is caused by ill health and malnutrition in early infancy ; and the less frequent variety, in which transverse lines are seen on the incisors, is due to exanthematous fevers or other acute illnesses. Arrested caries differs from active caries in its hard, smooth, and polished surface, and generally shows a deeply stained, dark brown discoloration. Teeth affected in either of these ways are often useful organs, and need careful inspection with a mouth-mirror and probe before being condemned. For a fuller description the reader is referred to works on dental pathology.

DENTAL CARIES AND DISEASE.

Prophylaxis and Preventive Treatment.—There can be little doubt that the prevalence of dental caries at the present day is intimately connected with the character of the diet ; but general conditions of health affecting the condition of the saliva are also important factors, and are probably responsible for the periodic attacks of dental caries which sometimes occur ; and recent investigations indicate that defective structure caused by lack of necessary vitamins in the food is a contributory factor. The initial process of caries consists in a decalcification of the enamel by lactic acid, produced by fermentation of carbohydrates remaining about the teeth and the interstices between them. Starchy substances are more likely so to remain than sugars, and it is thought that the modern use of roller-ground flour instead of stone-milled flour conduces to this end. But sugars dissolved in the saliva may remain around the teeth at the points of contact by capillarity, and it is probable that the monosaccharide glucoses now used in sweetstuffs are more readily decomposed than the disaccharide cane sugar of former times, which must be ‘ inverted ’ before being decomposed. The fibrous portions are now very generally removed from food-stuffs, and the result is a more sticky and adhesive material than the more natural product.

Children are usually given a diet which is too largely composed of much prepared starchy and sticky substances ; it is not generally recognized that after two and a half years of age or thereabouts, a healthy child is capable of masticating, and should be taught to masticate, most of the ordinary digestible food-stuffs used by adults ; and although rich foods, soups, spiced and seasoned articles, and stimulants should be excluded from a child’s dietary, it is very undesirable to go to the other extreme, and continue to feed a child, after three years of age, on food suitable for the transitional period between infancy and childhood when the temporary teeth are erupting.

Milk, bread, butter, eggs, farinaceous foods, simple puddings, fish, chicken, beef, mutton, natural gravy, certain vegetables, certain fruits raw or cooked, should form the principal items in a child’s dietary, and these substances should be given as far as possible separately, not as sloppy or sticky mixtures. If these principles were more generally acted upon, much of the dental caries so prevalent at the present day would be prevented.

More direct preventive treatment in children or adults consists in removal of food particles and deposit by means of the tooth-brush and suitable tooth-powder. The brush should be small, and with rather stiff bristles not too closely set together. It should be used the first thing in the morning and the last thing at night after the last meal, and should be moved up and down rather than across the teeth, so as to allow the bristles to pass into the interstices. A suitable tooth-powder contains as its chief ingredient precipitated chalk,

together with soap and an antiseptic. A useful prescription is :—

Pulv. Saponis Dur.		Olei Caryoph.	♏ij
Pulv. Iridis	āā gr. xxx	Cretæ Præcip.	ad ℥j

A more perfect method of cleaning the teeth consists in passing a strand of floss-silk dipped in tooth-powder between the teeth all round the mouth, but very few people will spend the necessary time.

Periodical inspection by a dental surgeon will enable small cavities to be detected and 'filled' with the least amount of trouble to patient and operator, and will almost ensure the preservation of the teeth in a functional condition throughout life.

Diagnosis.—The relief of pain caused by dental disease is the usual reason why a patient seeks treatment. Such pain may be felt in or around a tooth or be referred to some other part ; in the former case it is called odontalgia and in the latter neuralgia. Odontalgia may arise from several causes, but is usually due to inflammation or suppuration of the pulp, or to inflammation of the periodontal membrane or a commencing alveolar abscess. In either case the initial cause is generally dental caries, leading to exposure of the pulp, to irritation by heat, cold, acid or sweet substances, or variations in pressure, and to septic infection of the pulp, all usually accompanied by more or less severe pain. Gangrene of the pulp follows, and the dead pulp undergoes decomposition. Should any of this septic material pass through the apical foramen of the root, or be forced through by mastication, inflammation of the periodontal membrane results. This periodontitis may temporarily subside, but sooner or later, if untreated, often gives rise to alveolar abscess.

Other less frequent causes of odontalgia are secondary calcification in the pulp, direct traumatism, hypertrophy of the cementum, exposure of the cementum from alveolar absorption, pin-point absorption of the apex, and necrosis of the root.

Neuralgia may be caused by general diseases such as diabetes or gout. Excepting pain of this origin, neuralgia is divided into two classes : (1) Epileptiform neuralgia, or tic douloureux ; (2) Neuralgia minor ; the latter being subdivided into (*a*) True neuralgia minor, (*b*) Visceral referred neuralgia.

Epileptiform neuralgia is a rare disease, and is usually of central origin ; it arises independently of disease in the teeth, is intense and spasmodic in character, and is felt in the region of distribution of the trigeminal nerve on one side of the face.

True neuralgia minor may very closely resemble the more serious disease in its distribution, but there is always definite organic disease which is the real cause of the attacks of pain. This disease is generally situated in the pulp of a tooth rather than in the periodontal membrane, but may be any of those described as giving rise to odontalgia. Disease of a tooth in one jaw may give rise to pain in the corresponding tooth or another tooth in the other jaw ; disease in the third molar

frequently causes pain in a premolar in the same jaw. The cause and seat of the pain are always on the same side of the head.

Visceral referred neuralgia differs from the two preceding in several particulars. It is not always strictly neuralgic in character, but may be a fixed pain in certain regions ; it occurs sometimes in areas which do not correspond to the distribution of the fifth nerve, and is associated with tender areas which are very sensitive to tactile impressions. This form of neuralgia has, like true neuralgia minor, a definite objective cause, which may be any of those detailed above, and the tender areas have a fairly definite relationship to the various teeth of the same side. These areas have been carefully mapped out by Sir Henry Head.

It is obvious, then, that care has to be taken in diagnosing between the different kinds of neuralgia, and in finding the real seat of pain.

When the cause of the pain has been located in a particular tooth, there remains the need, for the purposes of treatment, to distinguish broadly between disease of the pulp and disease of the periodontal membrane.

The pain of acute inflammation of the pulp is of a sharp, stabbing character ; it is intermittent, is accentuated by hot or cold fluids, or by pressure or contact with food particles which find their way into the cavity, and is generally worse at night. As the result of irritation, there may be acute throbbing pain which gradually subsides, but should suppuration of the pulp supervene, the throbbing becomes more continuous. The tooth itself is not necessarily, or usually, tender to pressure or percussion. Chronic inflammation may produce similar symptoms to a less degree, or referred pain of a neuralgic character.

The pain of acute periodontitis is more continuous, deep-seated, dull, and persistently throbbing, especially when suppuration is commencing. The tooth itself becomes raised in the socket and is intensely sensitive to pressure, so that the patient avoids biting the teeth together. The pain is less affected by changes of temperature than pulp pain, but is increased by much warmth or extreme cold. Should alveolar abscess supervene, accompanied by much swelling, the pain ceases, owing to the escape of the pus through the absorbed alveolus into the more distensible tissues without. The abscess may point inside the mouth or on the face. There is usually much œdema, and the skin becomes red, shiny, and tense, especially over any spot where the abscess may tend to point. As in the case of the pulp, chronic inflammation produces less acute local pain and tenderness, or neuralgic symptoms.

Inflammation of the pulp and periodontal membrane may sometimes co-exist, as from injury, or by extension from the pulp to the periodontal membrane.

Palliative Treatment.—The pain of acute inflammation of the pulp is usually very amenable to treatment having for its object the ultimate preservation of the tooth. The cavity should first be cleared

of all loose débris and of as much of the decalcified dentine as can be removed without pressure being put upon the pulp. The cavity should then be made as dry as possible with cotton-wool, and if possible, with small pieces of amadou, and by warm air being gently blown upon it. It should then be carefully but thoroughly swabbed out with warm oil of cloves. This treatment usually relieves the pain almost at once, but if the cavity cannot be got reasonably dry, it is of little use, as the oil of cloves does not penetrate to the pulp ; in that case, and as a subsequent treatment, the best method is to insert a small piece of cotton-wool dipped in carbolized resin—phenol ʒiv, powdered resin ʒiv, chloroform ʒij—and slightly squeezed, and to cover this with another piece of cotton-wool saturated with a solution of gum-mastic or gum-sandarac in chloroform or ether, and only lightly packed into the cavity. Subsequent treatment by a dentist will consist in 'devitalizing' the pulp with an application of arsenious acid, removing the dead pulp, and filling the root canals, or in removing the pulp under 'pressure anæsthesia' with the aid of cocaine, and filling the root-canals.

In periodontitis the septic material has already passed through the apical foramen of a root, and only a very thorough antiseptic treatment of the pulp chambers and root-canals is of any use ; counter-irritation may, however, avail to alleviate pain and ward off the formation of an abscess. A small quantity of tincture of aconite and iodine should be painted on the gum around the tooth, and the patient should then rinse out the mouth. Or a small capsicum plaster may be applied to the gum over the root of the tooth on the buccal side, and left there until all the capsicum has become washed away by the saliva. If the inflammation does not resolve, or if the pain continues, hot fomentations applied round the tooth inside the mouth will often give relief. Half-a-dozen poppy capsules should be broken up, the seeds removed, and the remainder stewed in a quart of water until it has boiled down to a pint. Small sponges squeezed out of this lotion quite hot, and applied in succession to the gum, will frequently give relief. The patient should avoid swallowing the liquid. Fomentations should on no account be applied to the face, as this encourages a forming abscess to point outside the mouth, and leads to a sinus and permanent scar.

In case such palliative treatment proves successful, the subsequent treatment of periodontitis by a dentist will consist in rendering the cavity and root canals as aseptic as possible, and, after drainage and subsidence of inflammation, filling the root canals. It should be said, however, that a tooth which is the seat of periodontitis, especially if chronic, is less likely to become eventually a healthy and useful organ than one affected by inflammation of the pulp, and therefore that radical treatment by extraction is more justifiable.

Chronic Suppurative Periodontitis (*Pyorrhœa Alveolaris*).—In the periodontal membrane a chronically inflamed condition may arise

independently of sepsis derived from a dead pulp, and proceeding apparently from a superficial marginal gingivitis. The inflammation usually affects sound teeth, and spreads down the tooth-sockets, separating the gum from the teeth and producing pockets. The alveolus becomes the seat of a rarefying osteitis, and pus in variable amounts is generated. The necks of the teeth are usually covered by tartar, and the teeth gradually loosen and eventually fall out. The gums are inflamed and hyperæmic. The active cause is bacterial invasion of the tissue around the necks of the teeth, and of the pockets formed in the progress of the disease, but no specific organism has been isolated. Such is a description of the suppurative type of periodontal disease. It should not be considered, however, that suppuration is characteristic of progressive atrophy of the tooth sockets ; indeed, it may be regarded as a somewhat infrequent sign. The type of periodontal disease most common at the present day among those who pay attention to their teeth and mouth exhibits anæmic gums, gradual recession of the gums, progressive loosening of the teeth arising from alveolar absorption and rarefaction, with perhaps small deposits of hard or serumal calculus beneath the gum-margin, and little or no suppuration. It is this type that is thought to be most commonly associated with certain kinds of chronic arthritis, and it cannot itself be regarded as a purely local affection, but rather as a local manifestation of a constitutional condition.

Treatment.—If undertaken early this is usually successful in curing or checking the disease, but chronic cases of long standing are very intractable. In the hands of the dentist, treatment consists in removing all deposit from the teeth, and the application of antiseptic and astringent drugs, such as sulphate of copper, tincture of iodine, or peroxide of hydrogen. Ionic medication with chloride of zinc, iodine, or argyrol is very beneficial in some cases. Vaccine therapy has been tried with apparent success, but its utility is doubtful.

Oral Sepsis.—The ingestion of pus and septic material derived from carious teeth, the sockets of teeth, or from carious roots surrounded by an area of gingivitis, may be, and often is, the cause of serious illness, such as certain forms of anæmia, intestinal affections, endocarditis, arthritis, iritis, etc. When pyorrhœa cannot be cured, or at any rate kept well in check, the teeth should be removed.

It has been proved, moreover, in recent years that changes in the roots and surrounding alveolus caused by infection through the root canals of teeth with dead pulps, or from which the pulps have been removed, are frequently associated with infection of other organs. The use of X rays in conjunction with clinical examination is valuable for the diagnosis of pathological conditions of the roots of teeth, the periodontal membrane, and the alveolus. Care and experience are necessary to interpret radiograms correctly. Thickening of the cementum, thickening of the periodontal membrane, loss of bone at the alveolar margins, loss of the lamina dura or lining bone of the

socket, absorption of the apex of the root, granulation tissue or small chronic abscess, rarefaction of bone near to the root, or more distantly infected—these may all be seen. Rarefaction of bone is shown by lack of definition of the clear lines of cancellous tissue. In some cases there is evidence of reaction on the part of the bone shown by increased density, especially near the root. Pulpless teeth and roots to which solid artificial crowns have been fixed are not necessarily harmful, nor is marginal absorption of the alveolus when not accompanied by the formation of gum-pockets or suppuration, but pulpless teeth, or teeth with pockets, must be regarded with suspicion in any case in which there is evidence of infection of other organs. A tooth or root which cannot be made healthy and functional by conservative means of one kind or another should be removed.

EXTRACTION.

Extraction of diseased teeth may become necessary on account of looseness, or of mechanical roughness or sharpness, causing disease of the tongue, cheek, or gums ; or from urgency or inability to procure special treatment ; or for some of the reasons already mentioned. The extraction of sound teeth of the deciduous dentition may be called for by their undue retention, and consequent interference with the normal eruption of the permanent teeth ; and extraction of the teeth of either set may be necessary as the result of injury or disease of the jaws. The extraction of permanent teeth on account of irregularity in position should, as a rule, only be undertaken after consultation with a dental surgeon.

Preliminary Treatment.—The normal process by which the socket of an extracted tooth becomes filled by blood-clot is usually an effective bar to septic absorption. It is, however, desirable that the mouth should be in as hygienic a condition as possible, and the application of tincture of iodine to the gums, especially in the vicinity of the tooth to be extracted, is a useful prophylactic measure. In the case of multiple extractions under anæsthesia, presently described, when the mouth is not cleared at a single operation, it is particularly necessary that the mouth should previously have been got into as clean a condition as possible by the removal of calculus, local applications, and the use of mouth-washes. Even when all the teeth are to be removed, preliminary treatment is desirable to prevent septic matter being carried into the tissues by the blades of the forceps.

Principles of Extraction.—No mere verbal description of extraction will suffice to make the student proficient without observation of, and teaching by, the skilful operator, and frequent actual performance of the operation itself. It is of the utmost importance for the student to realize that *pulling or the application of violent force or indiscriminate wrenching* is likely to have no other result than fracture of the tooth, and possible serious injury to the jaw.

The patient should be sitting in a firm, strong chair, with the neck

and head well supported ; and the head should be leaning slightly backwards. The light should fall on the patient from the front, but slightly from his left and above his own level. The operator is always on the patient's right side, sometimes in front and sometimes behind, according to the tooth to be extracted.

Extraction is performed with forceps or elevators, which vary in shape and character with the teeth for which they are adapted. Forceps should be of sufficiently heavy pattern not to bend or spring under any strain which may be put upon them, as any such weakness greatly diminishes the sense of touch of the operator, and his ability to estimate quickly the resistance encountered. The handles of the forceps should be long enough to reach the interval between the thenar and hypothenar eminences ; they are usually made rather too short for large hands, and are then apt to shift in the palm when in use. The thumb should be pressed firmly between the handles close up to the hinge, so as to counteract the pressure exercised by the hand until the tooth or root is firmly grasped, when the thumb may be slipped along on to the face of the hinge to avoid being pinched in case the tooth should be crushed by undue pressure or insufficient penetration of the blades of the forceps, or the forceps should slip off the tooth or root (*Figs.* 285, 286). The elevator should be held with the handle firmly in the palm and the forefinger along the blade and reaching nearly to the end.

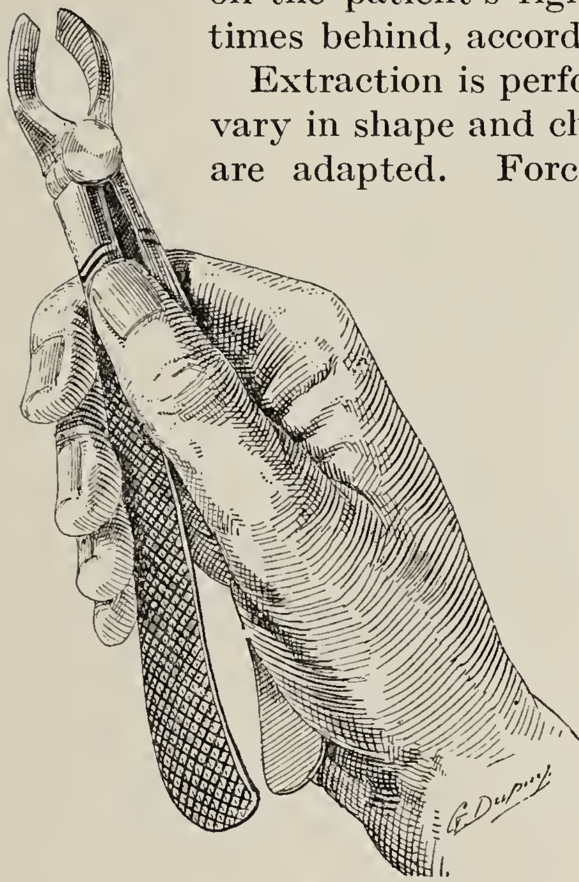


Fig. 285.—Showing manner of Holding Upper Forceps.

The left hand should be used to keep the soft parts out of the way and so obtain a clear view, and to grasp the alveolus, and also guard against a tooth or root falling down the pharynx, in case, as sometimes happens, it should shoot from the socket under the closing pressure of the blades of the forceps. When lower teeth are being extracted, the hand should also be used to support the mandible.

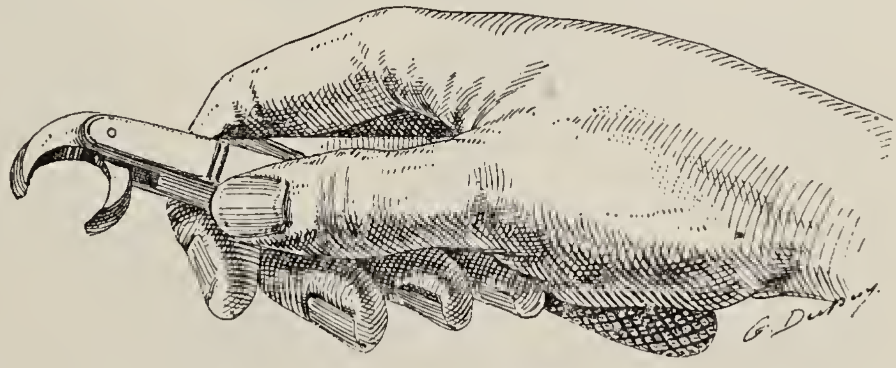


Fig. 286.—Showing manner of Holding Lower Forceps.

A general knowledge of the anatomy of the teeth and jaws on the

part of readers of this manual is assumed, but an examination of *Plate XIV* will show the usual arrangement of the sockets. Two chief points have to be remembered: (1) The teeth of the normal and complete arch are in close apposition, and the points of contact are nearer their buccal than their lingual surfaces; in other words, the individual teeth are roughly wedge-shaped, and form part of a continuous arch. (2) The alveolus, except in the case of the third lower molar, is thinner and weaker on the buccal than on the lingual aspect (*Fig.* 287). For both these reasons it is obvious that a tooth can be moved more easily outwards than inwards, and in the case of most teeth this is the chief movement which separates the tooth from the bone.

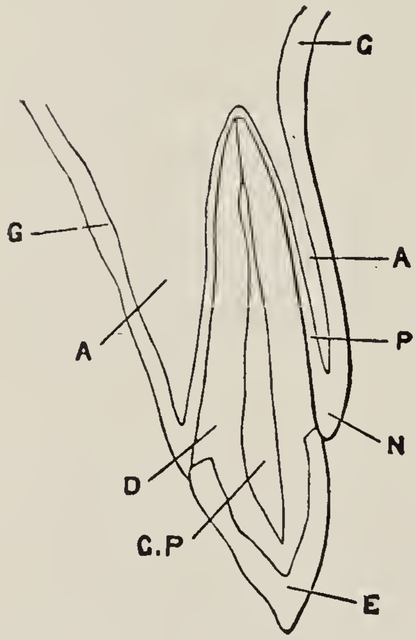


Fig. 287.—Diagram of Section through Upper Tooth and Alveolus.

A A, Inner and Outer Alveolus; G, Gum; D, Dentine; E, Enamel; C P, Pulp Cavity.

An important preliminary to extraction is a careful examination of the tooth or root in order to ascertain whether any abnormality is likely to be met with, such as thickened cementum, or adhesions to the bone from chronic periodontitis. Abnormality of the roots may sometimes be surmised from an unusual shape of the crown, especially in the case of an upper molar. The density of the bone varies considerably in different patients, men generally having denser bone than women, and women denser than children. As age advances, the alveolar bone becomes more unyielding, and the teeth more highly calcified and brittle, so that extraction becomes very difficult. The apical portion of a root, especially when curved or thickened, is then very liable to fracture. It is often impossible to remove such a small fragment at the time, or undesirable to attempt to do so. It may remain quiescent; or be absorbed; or it may in course of time come to the surface of the gum, or be a source of local irritation or inflammation or of focal infection. In the last case it must be removed. Roots partly covered by gum should be carefully examined with a probe in order to define the edges.

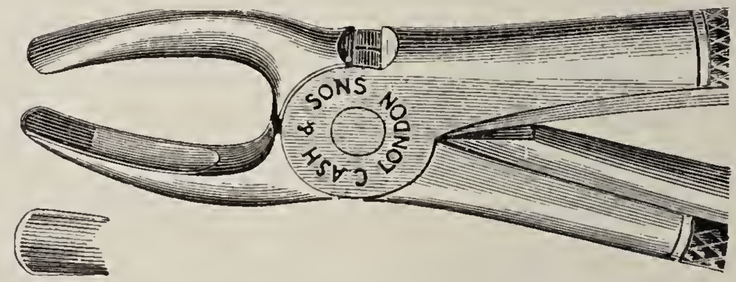


Fig. 288.—Forceps for Upper Incisors, Canines, and First Premolars.

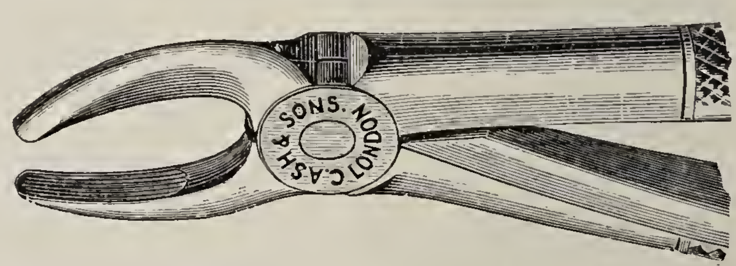
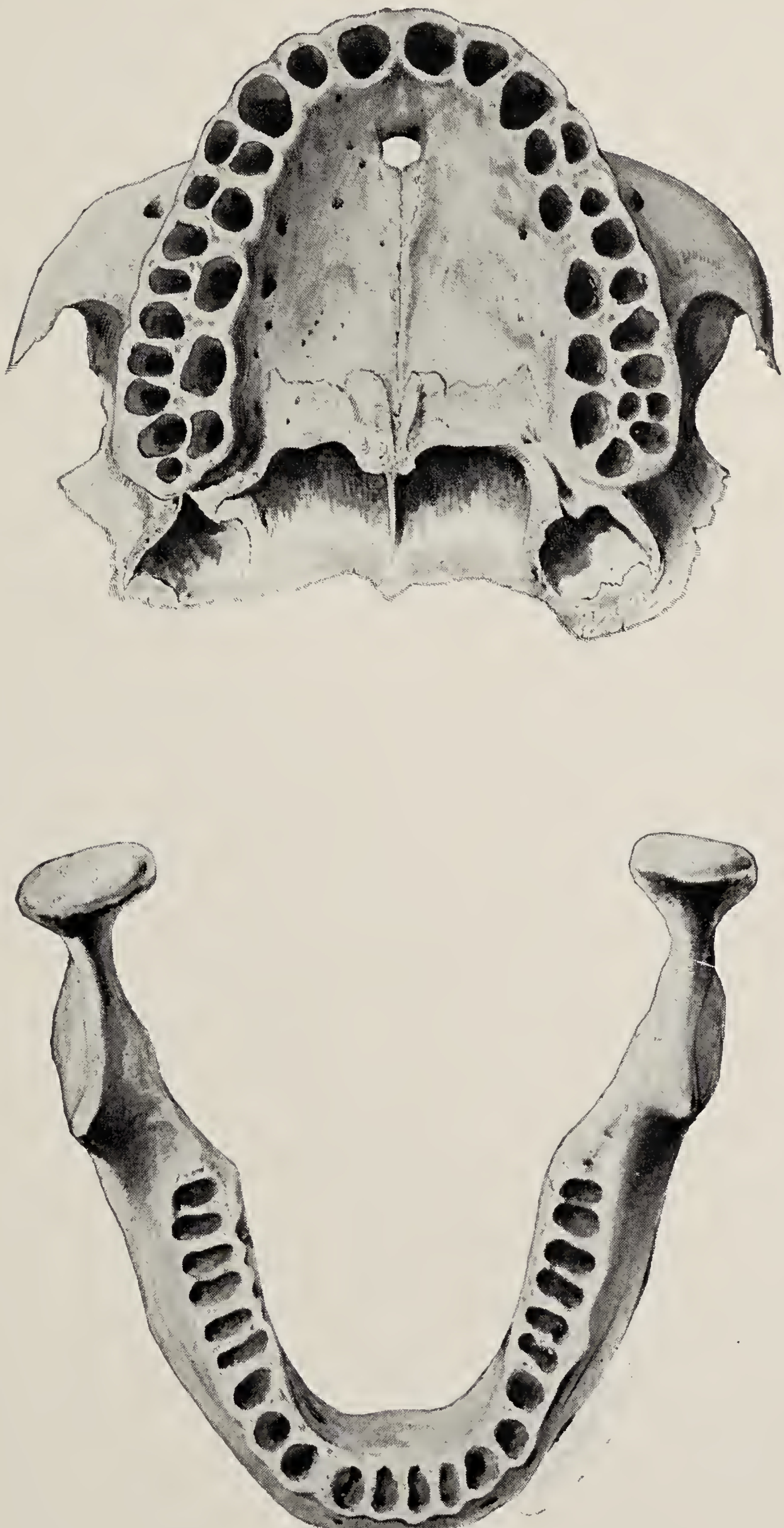


Fig. 289.—Forceps for Upper Second Premolars.

PLATE XIV

USUAL ARRANGEMENT OF THE SOCKETS OF THE TEETH



(From Cryer's *Internal Anatomy of the Face.*)

Extraction of teeth or roots should seldom be undertaken without the use of an anæsthetic of some kind, general or local (*see* p. 498, and Chapter L, p. 541).

Extraction with forceps consists of three stages : (1) Adaptation to the tooth or root ; (2) Separation from the alveolus ; (3) Removal from the socket and mouth.

In the first of these the blades should pass between the gum and the root, and be pressed firmly down with a slightly oscillating movement before being tightly closed. As a rule the inner blade should be applied first, but the exact method depends upon circumstances, and will be dealt with when the individual teeth are considered.

In the second stage the tooth is first slightly tilted inwards, and then steadily levered outwards until the outer plate of alveolus is fractured or sufficiently bent, and the periodontal membrane on the inner side ruptured; it is then levered inwards in a similar manner, but to a less degree, and the process is repeated until the tooth is separated from the bone. In the case of teeth with single conical roots, such as the upper incisors and lower premolars, rotation combined with tilting may be employed, but rotation alone without fracture or bending of the outer plate of alveolus is not usually sufficient. It is important to remember that, so far from being pulled from the socket, the tooth should rather be kept pressed firmly into the socket, especially when alveolar resistance is considerable. Neglect of this principle and loose closing of the blades are fruitful sources of transverse fracture.

The third stage consists simply in withdrawing the tooth from the socket after it has been sufficiently loosened, and it will often be found, even in the case of multiple-rooted teeth, that a slight rotatory movement combined with gentle traction will effect this best. The thumb and fingers of the left hand should closely surround the blades of the forceps until the tooth is removed from the mouth, and the tooth should not be lost sight of until this is safely accomplished.

The elevator should not as a rule be used except by fairly experienced operators, but the method of using will be considered in connection with the teeth for which it is best adapted.

Methods Applicable to Individual Teeth.—

Upper Incisors.—Straight forceps as shown in *Fig.* 288 should be used. The operator stands, as is always the case, on the patient's right side, and slightly in front. The inner blade should be applied first, and the tooth tilted slightly inwards, and then levered outwards and rotated at the same time. The forefinger and thumb of the left hand grasp the alveolus, the former also holding the lip out of the way (*Figs.* 290, 291).

Upper Canines.—The method is similar, but on account of the length and shape of the root, more force is necessary and rotation is less useful.

Upper Premolars.—Straight forceps should be used for the first

premolar, and may be used for the second, but for the latter it is usually advisable to use slightly curved forceps, as shown in *Fig.* 289. The roots are flattened and do not permit of rotation, and that of the first premolar is usually bifurcated. The operator stands as for incisors, applies the inner blade first, then tilts the tooth slightly inwards, and then firmly outwards. If the alveolus does not give way, a more forcible inward, followed by the outward, movement should be repeated. The tooth should not be pulled, but rather kept firmly pressed into the socket.

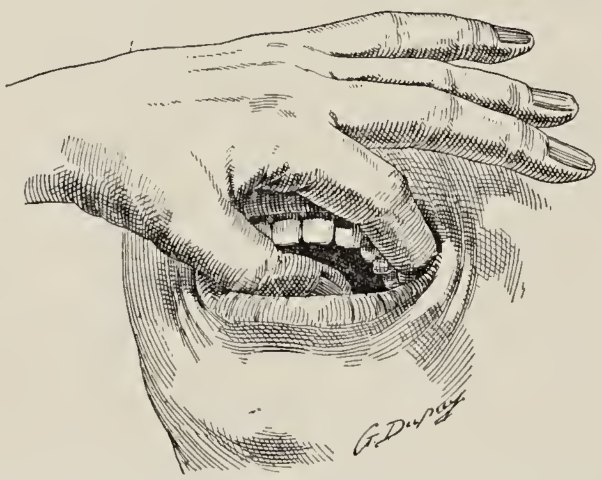


Fig. 290.—Showing Use of Left Hand when Operating on Left Side of Upper Jaw.

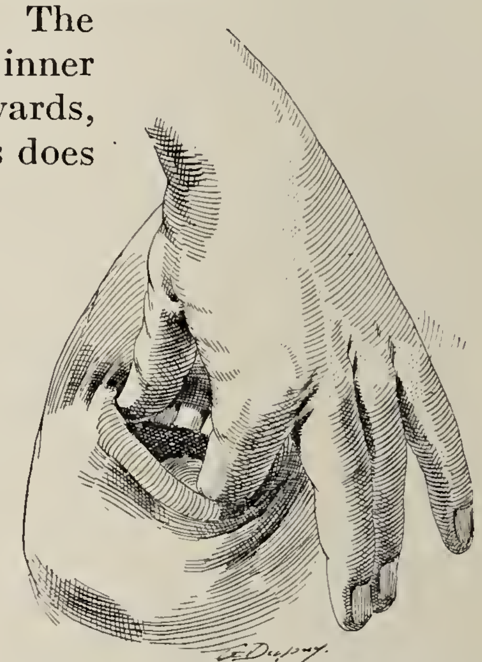
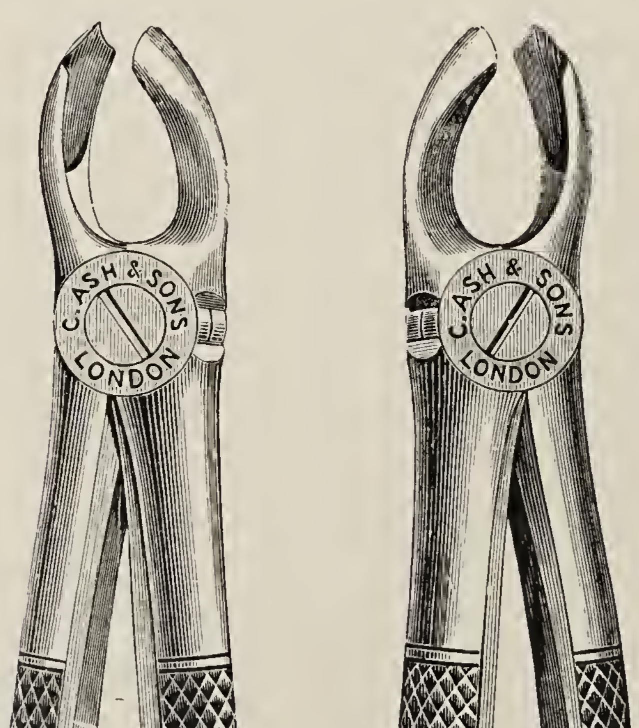


Fig. 291.—Showing Use of Left Hand when Operating on Right Side of Upper Jaw.



Figs. 292, 293.—Forceps for Upper Molars (Right and Left).

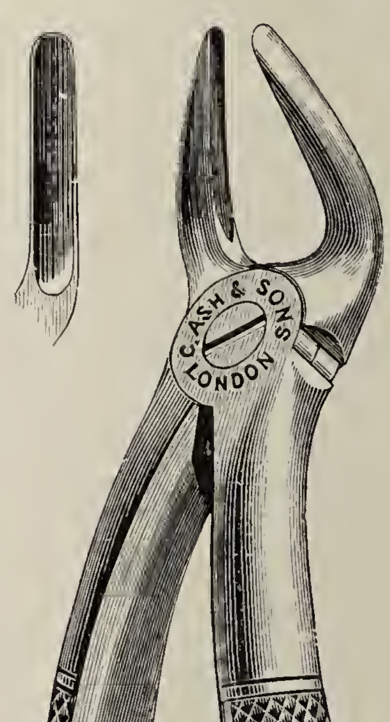


Fig. 294.—Forceps for Upper Molar United Roots.

Upper Molars (*first and second*).—The forceps used should be strongly and rather heavily, but not clumsily, made. An upper molar tooth has two small roots on the buccal side, and one large on the palatal ;

different forceps are therefore required for the two sides, as shown in *Figs.* 292 and 293. The outer blade in each case is pointed and has two grooves, and the inner blade has one larger groove. It is important to remember, when applying the forceps, that the inner blade should be distinctly posterior to the outer, and that the latter should be kept well forward on the anterior buccal root; also that the handles should be kept well back, and the lower lip prevented from being pinched between them and the lower teeth. The position of the operator and the method of loosening the tooth from its socket are the same as for premolars, but it will often be found that for removing the tooth from the socket after loosening it a slight rotation of the outer blade forwards is useful.

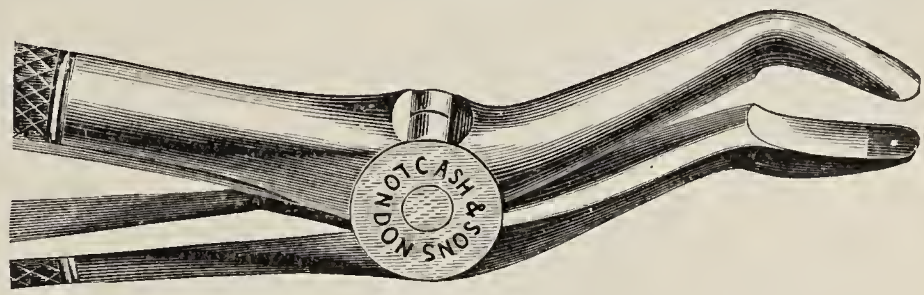


Fig. 295.—Forceps for Upper Molar Separated Roots.

Upper Molars (*third*).—The same forceps may be used, but, as the tooth is less accessible, and the roots are usually smaller and sometimes fused, a pair of forceps with a greater curvature, and with two blades similar to the palatine blade of the molar forceps, is generally more efficient. It is important to apply the blades very carefully, as there is some risk of tearing the gum, or even of fracturing the tuberosity.

Upper Molar Roots.—When the crown of the tooth is much broken down, and caries extends below the gum level, root forceps, as shown in *Fig.* 294, should be used, to grasp usually the anterior buccal and palatine roots. One blade should be applied first to the root which is less decayed, and then the other blade very carefully to the root more decayed below the gum. Tilting should be first towards the more decayed root, and the forceps should be pushed firmly up at the same time, the thumb and forefinger of the left hand grasping the alveolus firmly and preventing slipping. Movement to loosen the roots should be almost entirely in the direction of the more decayed root. When it is found impossible to loosen the roots in this way, or when all the roots are much decayed below the gum, it will sometimes be found that by applying the outer blade to the posterior buccal root and the inner blade anterior to the palatine root, the roots may be divided and one or more brought away at the first attempt.

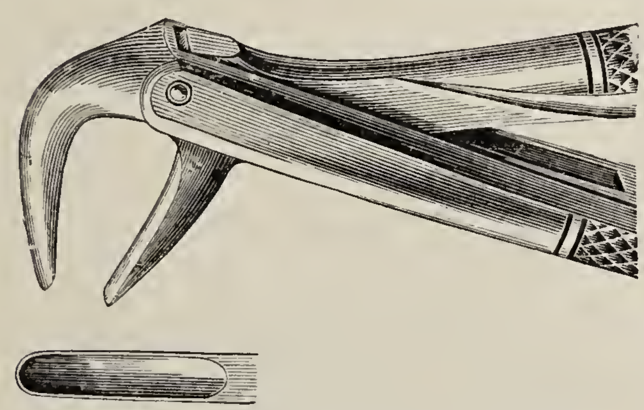


Fig. 296.—Forceps for Lower Incisors, Canines, Premolars, and Molar Roots.

When the roots are divided they may easily be removed separately with a slight movement of rotation. For the removal of single roots of an upper molar, rather finely pointed, bayonet-shaped forceps, as shown in *Fig.* 295, are usually employed.

Lower Incisors and Canines.—Forceps as shown in *Fig.* 296 should be used. The patient should be on a low level, and the operator should stand on his right side and slightly in front. The lingual blade should be applied first, and the same methods followed as for upper premolar teeth. The lip should be kept out of the way with the forefinger of the left hand, and the tongue with the second finger, the thumb being used to support the chin.

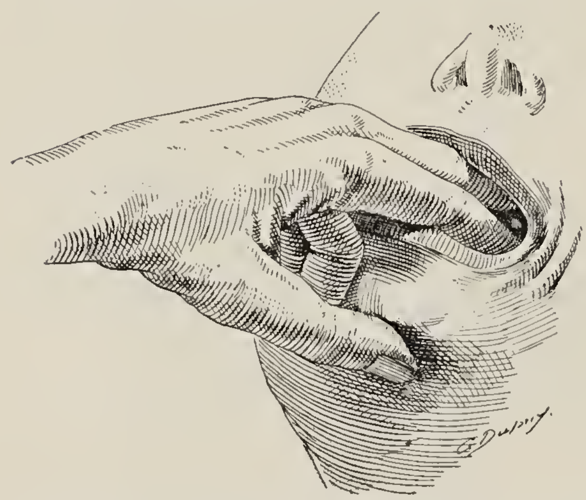


Fig. 297.—Showing Use of Left Hand when Operating on Left Side of Lower Jaw.

Lower Premolars.—The same forceps are used, and as the roots are more or less conical, rotation alone, or more usually in combination with tilting, may be employed. The position of the operator in extracting on the left side of the mouth is the same as for incisors, but for teeth on the right side he should stand behind the patient and bring the left arm round the patient's left side. For the left side the alveolus should be held between the first and second fingers of the left hand with the thumb supporting the mandible (*Fig.* 297) ; for the right side the alveolus should be grasped with the thumb on the lingual side and the forefinger on the buccal side, and the other fingers should be used to support the mandible (*Fig.* 298).

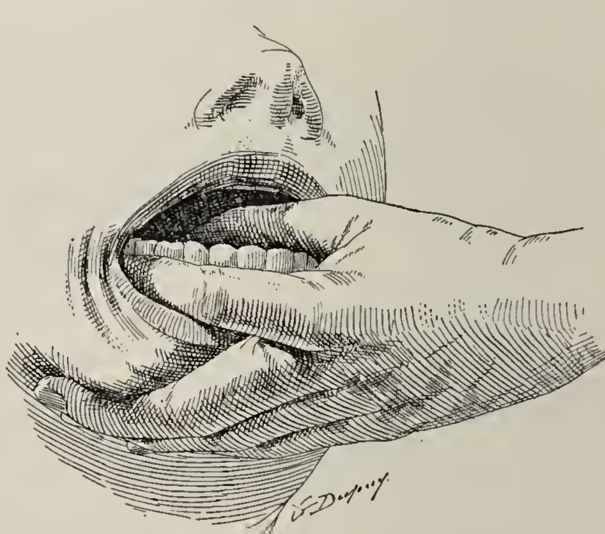


Fig. 298.—Showing Use of Left Hand when Operating on Right Side of Lower Jaw.

Lower Molars (*first and second*).—Forceps as shown in *Fig.* 299 should be used, the points of the blades passing between the two roots. The position of the operator and the use of the left hand are the same as for premolars. The inner blade should be applied first, and it is important to be careful that the forceps are square to the tooth, with the hinge well back. The forceps should be pressed firmly down with the left hand, the second finger being used on the left side and the thumb on the right ; and the handles should be on a higher level than the blades, because the teeth usually lean inwards. Until the tooth is thoroughly loosened from its socket, no movement of traction should be made ; the tooth should

rather be kept firmly pressed into its socket in order to avoid fracture.

Lower Molars (*third*).—The same forceps may be used and the same positions adopted as for first and second molars ; or a pair of forceps with straight handles and curved blades may be used, the operator then standing in front when extracting on either side. In loosening this tooth from its socket, inward tilting is more useful than outward, because of the thickness of the outer alveolar plate. The best instrument for raising a lower wisdom tooth from its socket is a straight elevator, *Fig.* 300. This should be held as previously described, with the handle in the palm of the hand and the forefinger along the blade ; when extracting a tooth from the left side of the jaw the operator stands in front of the patient and has his forefinger along the flat side of the blade of the elevator, and when extracting from the right side he stands behind and has his forefinger along the convex side of the blade. The root or roots of the tooth usually curve backwards. If, therefore, the point of the elevator is firmly pressed down between the anterior surface of the root and the alveolus on the buccal side (that is to say, into the interval between the second and third molars), with the flat side next the tooth, and the handle is pressed downwards, the tooth will be tilted backwards. The point should then be pressed further down with a lightly rotary movement and the process repeated. After the tooth has been loosened in this way, it is sometimes convenient to remove it with forceps. It is important to guard the tongue and soft parts with the left hand in case of the instrument slipping ; and as there is some risk of the operator cutting his finger, it is wise to be cautious about using the elevator in septic mouths or those affected by specific disease.

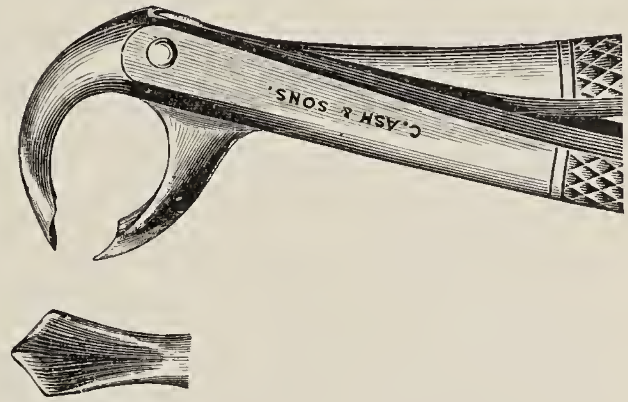


Fig. 299.—Forceps for Lower Molars.

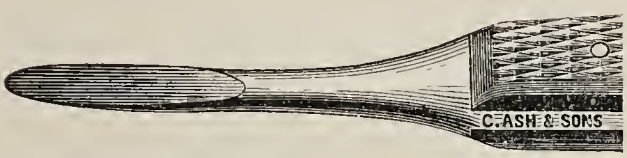
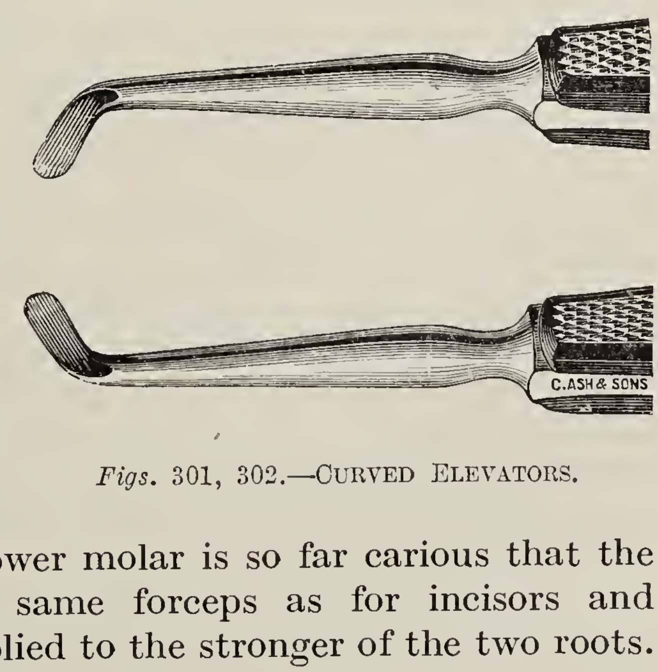


Fig. 300.—Straight Elevator.



Figs. 301, 302.—Curved Elevators.

Lower Molar Roots.—When a lower molar is so far carious that the roots are nearly separated, the same forceps as for incisors and premolars should be used, and applied to the stronger of the two roots.

When one root has been removed it is usually easy to remove the other by means of a curved elevator (*Figs.* 301, 302). The point should be passed down to the bottom of the socket of the extracted root and through the bony septum, and the handle so rotated as to force the root up from below; or the point may be pressed between the root and the adjacent tooth, and the handle rotated so as to force the root into the socket of the extracted root.

Deciduous Teeth are removed in a similar way with smaller instruments. The blades should not be pressed down too far for fear of injuring the permanent teeth below. It should be remembered that the roots of deciduous molars are usually divergent and firmly implanted, and that when these teeth are removed before the roots have become absorbed, the pain of extraction, when an anæsthetic is not being used, is considerable. For such teeth complete anæsthesia, general or local, is necessary; but for single-rooted teeth, or loose teeth or roots, freezing with an ethyl chloride spray is often sufficient.

Complications and Casualties of Extractions.—

Fracture of the Tooth.—This is generally due to the blades of the forceps not penetrating deeply enough, or not being closed firmly, one blade thus being allowed to slip slightly; or to the forceps not being kept firmly pressed down until the tooth is loosened from its socket; or to hurry in manipulation. The roots should be carefully defined and removed if possible, but if this proves difficult they may be left for a few days, when inflammation will probably have made the operation easier. Failing this, they may be removed at a later date under local anæsthesia. It is sometimes impossible to prevent the apex of a root with thickened cementum from breaking off.

Extraction of the Wrong, or an Adjacent, Tooth.—The tooth should be washed in warm water and replaced in its socket, and the mandible should be fixed with a four-tail bandage. The patient should be advised to consult a dentist with a view to possible future treatment of the pulp.

Fracture of Bone.—Fracture of a small portion of alveolus is of little consequence. More extensive fractures must be treated with appropriate splints.

Trismus.—An anæsthetic should be administered and the mouth carefully opened with a Mason's gag.

Laceration of the Gum.—Torn portions of gum usually reunite if pressed into place. An extensive tear may require a ligature. A fragment only adhering by a thin pedicle should be removed with scissors.

Hæmorrhage following tooth extraction may be serious, and demands prompt treatment. It may be due to the hæmorrhagic diathesis known as hæmophilia, and the extraction of a tooth for a patient known to be a subject of this disease to a marked degree should not be undertaken except from absolute necessity. Infected gum-tissue is more prone to hæmorrhage than healthy gum-tissue. When it is necessary to extract teeth for a patient known to bleed freely or for

a long time from small wounds, an endeavour should be made to get the patient into as good general condition as possible, and lactate of calcium in 30-gr. doses three times a day may be given for three days beforehand. The operation should be done in the morning, and only one tooth should be removed at the first sitting.

Hæmorrhage after extraction may be primary, reactionary, or secondary. In the first case very hot or ice-cold water with some tincture of hamamelis should be tried, and the patient should allow the blood and water to run from his mouth, as spitting, by causing suction, encourages hæmorrhage. If this fails, the socket must be cleared of clot as well as possible and plugged with a strip of boracic gauze, soaked in adrenalin chloride and firmly squeezed out, and carrying as much tannin as it will take up. The gauze should be firmly packed into and above the socket, and firm pressure maintained on it, and on both sides of the gum and alveolus, with the fingers. This will usually check the bleeding, and the jaw may then be fixed with a four-tail bandage, so that the upper teeth bite firmly on the packing and keep it pressed well down ; the plug may have any loose portions above the socket cut away after twelve to twenty-four hours, but should not be removed entire until it has become loose by itself. Sometimes the extracted tooth, after being washed, may be used as a plug, either alone or with a layer of gauze intervening, and kept in position by the opposing tooth with the aid of a four-tail bandage. A dose of gallic acid, 15 gr., may be given, and repeated every two hours for the next twelve hours if the hæmorrhage does not cease. The patient should be kept under observation, and fed on cold liquids, and be told to remain quiet, and not lie down at all, or at least not without the head well propped up. Severe hæmorrhage sometimes occurs from the gums and may be more difficult to control than from the socket. Digital pressure with gauze as described may be required for a considerable time. Some practitioners attach much value to the use of oil of turpentine for arresting hæmorrhage.

Reactionary hæmorrhage usually commences some hours after extraction. It may be from the gum, but is usually from the socket. The same local treatment as that described for primary hæmorrhage should be adopted. Suture of the gum over the socket after or before packing is sometimes employed. In cases where the blood shows but little tendency to coagulate, hæmostatic drugs, such as gallic acid, or a large dose, ʒj, of calcium lactate, should be given internally ; but where the blood coagulates in the mouth a more suitable drug is one which causes contraction of the vessel walls, and a hypodermic injection of ergot may be given ; an objection to ergot is that it raises the blood-pressure. Pressure on the common carotid may be employed, and failing these measures, surgical interference may be necessary.

Secondary hæmorrhage, which is comparatively rare, requires similar treatment.

Pain Continuing after Extraction usually subsides without treatment, but hot fomentations inside the mouth over the socket will give relief. Pain continuing for long after extraction is generally due to septic inflammation. The socket should be swabbed out with a small quantity of carbolic acid, 1–20, and kept frequently syringed with a more dilute antiseptic. Injury to the inferior dental, and to the lingual, nerve has been recorded.

Dislocation of the Mandible occasionally happens, usually under an anæsthetic, but reduction is easily effected.

Extraction under General Anæsthetics.—The general principles for extracting under anæsthetics are the same as described above, but there are a few points worthy of special remark.

With short periods of anæsthesia it is unwise to attempt to do too much in the time ; and although the operator should of course have everything ready, in order to commence operating immediately the face-piece is removed, time is never wasted in applying the forceps carefully and thoroughly, or in reapplying them if the grasp is unsatisfactory. Experience alone will enable the operator to estimate at once by his sense of touch the amount of force necessary to loosen the tooth from its socket.

When extracting lower teeth, it is important not to depress unduly the root of the tongue or the mandible. A momentary pressure on the tongue with the thumb or a finger of the left hand, while the inner blade of the forceps is being applied, is permissible, if respiration is not seriously impeded. The mandible should be well supported with the left hand.

The removal of the tooth from the mouth should be done with care, and during the whole operation of extraction the thumb and one or more fingers of the left hand should surround the tooth, in order to avoid risk of the tooth dropping down the pharynx, and possibly into the trachea. This precaution is especially necessary when upper molar teeth or roots are being extracted. If a tooth or root slips from the forceps into the mouth, the patient's head should at once be tilted forwards, and the tooth found and removed before any further operation is proceeded with ; in case the tooth drops on to the root of the tongue, care should be taken not to push the tooth further back or induce a deep inspiration by trying to hook the tooth forward with the forefinger, unless it can be seen and removed with safety. It is much better for the patient to swallow a tooth or root than to inhale it, but if the head be kept well tilted forward neither accident is likely to happen.

When several teeth are being extracted, the lower teeth should be removed first, so as to avoid as far as possible the difficulties occasioned by hæmorrhage, and for the same reason the most posterior lower teeth should be removed first of all, but lower roots should usually be removed before lower teeth.

The extraction of a large number of teeth under a long period of

anæsthesia is an operation not altogether to be commended, on account of the degree of surgical shock with feeble persons, and the risk of septic absorption through extensive damage to the tissues, or of septic pneumonia and gangrene of the lung. Furthermore, the condition of the patient for a week or two afterwards is a somewhat unhappy one ; mastication is impossible, and a milk diet necessary. For the last reason, extraction limited to one side of the mouth at a time is to be recommended ; but in the case of a very septic mouth, this half-measure is less advisable than the removal of only a few teeth, or a complete clearance of all septic teeth and roots at one sitting, because the opportunities for septic absorption are at their maximum.

When extractions are being carried out on both sides of both jaws, the best order of procedure depends to some extent on the number of teeth to be removed from the lower jaw. When several lower teeth on each side are to be removed, the operator should commence at the back of that side of the mandible in which there are most, then cross to the other side, then extract the upper teeth on the same side, and finally the upper teeth on the side on which he first started, in each case proceeding from the back forwards ; a large sponge may be inserted on the side which has been operated on, and held in place by the Mason's gag. This plan involves the shifting of the gag twice, but is the quickest and best in the end. When, however, there are only a few teeth to be removed on one side of the lower jaw, and these are not likely to give much trouble, it is justifiable to complete the other side first, both upper and lower. It should be remembered that some of the unpleasant after-effects, especially vomiting, are occasioned more by the swallowing of blood than by the anæsthetic itself, and this should be prevented as far as possible by frequent sponging with moist sponges squeezed as dry as possible. When the anæsthetic is given through a nasal tube, the swallowing or inhaling of blood or other substance from the mouth may be effectually prevented by packing the pharynx with gauze.

After-treatment.—In all cases where a large number of teeth have been removed, and in many others where the mouth is more than ordinarily septic, or the tissues have been much damaged, a mouth-wash should be prescribed, to be used morning and evening, and after every meal. In some cases, it may be advisable to syringe an antiseptic lotion into the socket or sockets. A useful mouth-wash is :—

℞	Liq. Potassæ	ʒj	Tinct. Cocci	q.s.
	Acid. Carbol. Liq.	ʒss	Aq.	ad ℥j

Misce. Sig. : *Not to be taken.* Use one teaspoonful in half a tumbler of warm water as mouth-wash.

Or, of a milder character :—

℞	Acidi Borici	gr. x	Aq.	ad ℥j
	Zinci Sulph.	gr. iij		

Misce.

TREATMENT OF ALVEOLAR ABSCESS.

In order to prevent serious conditions and symptoms supervening, and to avoid the pointing of the abscess outside the mouth, the first essential is to evacuate the pus. This may be done in two ways, namely, by removing the tooth or by incising the abscess. When the general swelling is considerable, and there seems to be any possibility of cellulitis spreading to the neck, or when the abscess is about to point outside the mouth, the tooth should always be extracted. This should be performed at once ; and if the pus is not freely evacuated through the socket, or if the abscess is pointing inside the mouth and at some distance from the tooth, the abscess should be freely incised as well. The risks of anæsthesia with a brawny cellulitis of the neck should not be forgotten. When, however, the symptoms are less urgent, incision of the abscess will suffice to give immediate relief, and subsequent treatment by a dental surgeon may restore the tooth to a healthy condition, especially in the case of an acute abscess arising for the first time in connection with a particular tooth. This course is particularly desirable in the case of upper incisors and canine teeth when circumstances permit. A lotion for use as a mouth-wash or for syringing the abscess cavity should be prescribed, and the patient should be given a purge.

SECTION IX

OF CERTAIN EMERGENCIES, SURGICAL AND GENERAL

CHAPTER XLVI

OF HERNIA, INTESTINAL OBSTRUCTION, AND ACUTE ABDOMINAL LESIONS

CASES of rupture, with symptoms of obstruction, more or less marked, are of very frequent occurrence in any large hospital, and the proper discrimination of the different kinds and degrees of this condition is a most difficult and responsible part of a house surgeon's work. It is true that the actual herniotomy is usually performed by the visiting surgeon, but this may be the simplest part of the whole treatment, while the house surgeon has to decide upon points which are often obscure—whether the question of operation ought at once to be raised, whether taxis should first be tried, and if so, for how long, whether a preliminary bath should be given, and so on. Here the rule already laid down most strictly applies, namely, *when in doubt send for the visiting surgeon.*

Typical Case of Strangulation.—In considering the rules which should govern the management of these cases, we will take first a typical hospital case, in which symptoms of well-marked strangulation have existed, we will suppose, for twenty-four hours, and where without the use of an anæsthetic the hernia has not been reduced by moderate taxis. It will, first of all, be important to know if the hernia be one of long standing which has suddenly become much larger, or whether this is the occasion of its first appearance, and, in the former case, whether or not a truss has been habitually worn. These questions bear upon the amount of taxis which it may be safe to employ. Thus, a small hernia, down for the first time, is probably more tightly nipped and requires more tender handling than an old-standing one in which the canal is certainly dilated and a portion, at any rate, of the gut is accustomed to slip to and fro.

The house surgeon must then exercise his discretion as to whether a further trial may fairly be made of the taxis, then and there ; but as a rule, unless distinct gurgling or other indications show that the strangulation is very slight, he will be wise if he confines his manipulations to those which are necessary for the ascertaining of the condition of affairs.

He must next decide between sending for the visiting surgeon at once, or first trying the effects of a hot bath, to be, perhaps, followed up by an injection of starch and laudanum. The former is now the usual course adopted. But should the bath be decided on, it should be hot (102° to 104°), and the patient should stay in it until there is a slight feeling of faintness. Taxis *may* then be tried in the bath, but it can be performed more conveniently on the bed, the patient lying between blankets. Only a moderate amount of taxis should be tried, for it is often found that the vitality of the strangulated gut has been further jeopardized by the free manipulations made in attempting to reduce the rupture. If the hernia cannot be reduced, no time should be lost in sending for the visiting surgeon and preparing for herniotomy.

In the case of a very acute strangulation in a rupture down for the first time, there is no doubt that operation should not be delayed, for with the antiseptic methods now in practice the risks of the operation itself are comparatively small, and time occupied in giving a bath and attempting further taxis may, or probably will, only lead to greater congestion of the strangulated part and increase the chances of gangrene of the intestine. The house surgeon then should at once send for his chief and make all preparations for the operation.

In the cases we have hitherto considered, the strangulation has not been supposed to have been of more than twenty-four hours' duration. Unfortunately, a large proportion of hospital cases of strangulated rupture are not sent in until the symptoms have been present for days. In such a case it will always be at any rate doubtful as to whether the intestine can bear even the gentlest taxis, and it may be in a condition in which it would not be right to return it into the abdomen, even if it were possible to do so. Here every hour's delay is hurtful, and the house surgeon should immediately send for the visiting surgeon, get everything ready for herniotomy, and leave the question of making any attempt at reduction by taxis to his senior's discretion and responsibility.

Cases of Doubtful Strangulation.—But all ruptures which cannot be returned, or are difficult to return, are not strangulated, even though in some cases there be a certain amount of distress and nausea. Clinical experience, not to be learned from books, will alone enable these to be distinguished with certainty ; but although some will remain doubtful until cleared up by the course of events, the house surgeon will generally be able to distinguish readily enough whether strangulation is really present.

The cases which require most discretion are those in which at first there are no symptoms indicating that the gut is nipped, beyond the fact that it cannot be returned, and then gradually the case becomes doubtfully, and at last distinctly, one of strangulation. Although in doubtful cases of this kind the visiting surgeon will very probably have some difficulty in deciding when to operate, still it is certain that he should be given the opportunity of doing so early ; so that the

plain duty of the house surgeon is to send for him as soon as any question of the existence of strangulation arises, and it should be remembered that in cases of umbilical hernia of long standing the symptoms of strangulation are frequently very indefinite.

A rupture should never be thought lightly of because it is small ; on the contrary, it is the small knuckles of intestine which get most tightly nipped, especially in femoral herniæ, and, as we have said before, those which suddenly develop in consequence of some strain are more likely to be very acutely strangulated than long-standing ones.

Taxis.—A word or two may be said as to the performance of *taxis.* Whether an anæsthetic be used or not, the leg and trunk must be put into the position which will mechanically relax the margins of the apertures, and the greatest possible gentleness should be exercised. This must be specially kept in mind when the patient is under ether or chloroform, when absence of complaints does away with one safeguard. *The amount of damage which may be done by rough taxis must be seen to be believed.* The gut may be ruptured or bruised into gangrene, and the sac, or the more superficial tissues, may be so gravely injured that they will presently slough. Many surgeons object altogether to the practice of taxis ; but if carefully carried out it may be employed in suitable cases. The following rules with regard to it will be found useful :—

1. Place the patient in a recumbent position, the head being supported by a pillow, the pelvis slightly higher than the shoulders ; the hips and knees should be bent, and the soles of the feet should rest on the bed. The bladder should be emptied. Uniform pressure is to be exerted upon the hernia, in a direction upwards and outwards for the inguinal variety, inwards and upwards for the femoral.
2. Never apply taxis for a longer period than two minutes ; this includes an attempt with and without an anæsthetic.
3. Use no force : only that amount of pressure that can be brought to bear by the fingers and hand.
4. Never attempt taxis if the hernia has been strangulated (definite symptoms, vomiting, etc.) for more than twenty-four hours.
5. Do not attempt it in cases where the first appearance of a hernia is associated with signs of strangulation. In such cases the contents are very tightly nipped, and taxis will almost certainly fail.
6. In femoral hernia taxis is more dangerous than in the inguinal variety.
7. If the taxis is apparently successful, always admit the patient and watch him carefully for twenty-four hours. If the symptoms persist, they are due to some mischance in connection with the taxis, and immediate operation is required.

Before taxis, and above all before any operation is performed, see that the bladder is empty.

Rupture without Strangulation. — Ruptures which are difficult or impossible to reduce, but which are not strangulated, can hardly

be said to be emergencies ; nevertheless we may here shortly consider them. Very often a few hours' rest in bed, in the supine position, with the buttocks slightly raised on a pillow, will enable reduction to be effected, and, in old-standing cases especially, the patient should be allowed to try to put the rupture back himself if he can, for he will often succeed when the surgeon would fail.

The *ice-bag*, or in old people a fomentation, may be of use occasionally, but the recognition of such cases is difficult, and it is far better to relieve even an unstrangulated hernia by operation than to wait for a possible but doubtful relief to be gained by an ice-bag. An irreducible hernia must always be looked on as a danger.

The warm bath, followed by a simple enema, or one containing opium as before described, is here also frequently of great service ; but in the absence of disquieting symptoms, patience and rest in bed are the great agents for effecting the reduction.

A rupture is sometimes permanently irreducible in whole or in part, in which case, if operation is contra-indicated, the only thing to do is to have a truss of a special shape made for its support and protection.

Cases of Intestinal Obstruction, which usually require immediate operation, only come under notice here in connection with the examination and preparation which the house surgeon should make.

When a given case of obstruction is admitted to the hospital, there may or may not be considerable doubt as to the accuracy of the diagnosis, and although the house surgeon will naturally inform his chief, he can by a thorough preliminary examination give his surgeon considerable assistance.

In obtaining a history of the case, the points of special importance to be noted are :—

1. Mode of onset, with or without pain ; if with pain, its position and extent.
2. History of previous attacks in any way similar.
3. The character, frequency, and duration of the vomiting.
4. The state of the pulse and temperature.
5. The condition of the abdomen : (*a*) Distended or not ; (*b*) Visible peristalsis ; (*c*) The presence of any lump or mass ; (*d*) Local tenderness or area of muscular rigidity.
6. The appearance of the hernial orifices. *These must be systematically examined in all cases of obstruction*, or a small strangulated hernia may be overlooked.
7. The presence of any scar denoting a previous abdominal operation should be noted.
8. *The result of a rectal examination.* This examination must never be omitted. In many cases it affords some information as to the cause of the obstruction. Some cases of carcinoma of the rectum first present themselves with symptoms of acute obstruction, and in intussusception a mass can be felt in a fair number of cases.

Having paid due regard to these details, if the diagnosis is doubtful,

and the vomiting is not urgent, and the pulse is quiet and of good volume, the house surgeon should order an enema—at first an oil injection slowly given, followed by a turpentine solution. If these produce no result, he may try the effect of an enema made up as follows :—

℞	Magnes. Sulph.	℥j	Ol. Ricini	℥j
	Calomel	gr. x	Glycerini	℥vj

Such an enema is useful in cases where the previous enemata have been retained.

If the above treatment produces no effect, the patient will probably require an operation, and all preparations should be made pending the arrival of the surgeon. *In no case of suspected obstruction should the house surgeon ever order a purge.*

Obstruction from Accumulation of Fæces must be considered. The obstruction is situated usually in the upper part of the rectum or sigmoid flexure, and occurs most commonly in women or in children as a sequel to some severe illness, such as typhoid fever, but examples may be found in patients of either sex, and at any age.

Usually a history will be given of habitual constipation, steadily getting more and more difficult to overcome, until finally there may have been no relief by the anus for a period to be measured by weeks. In other cases some fæces may have been passed, but the bowel has never been properly unloaded. On examining the patient, it will probably be found that the intestines are greatly distended with flatus, while in the left iliac region or in the position of the transverse colon a soft doughy tumour is to be felt, the shape of which may be altered by manipulation, which is generally borne well, although it may be that a certain degree of inflammation of the surrounding parts has been set up. In any case distress and nausea will be present, and the symptoms may be sufficiently severe to mask the real nature of the trouble and to make it resemble a case of acute obstruction due to some mass of new growth in the situation of the sigmoid flexure, or to an intussusception or volvulus of the bowel. A thorough digital examination of the rectum ought never to be omitted.

The treatment in these cases consists in unloading the sigmoid flexure and rectum as speedily as possible. In the first place all the fæcal matter which can be dislodged from the rectum by the finger or a spoon should be so removed, and masses somewhat higher up may be got at by a scoop or spoon with a longer handle. A pewter tablespoon, bent so as to diminish the width of the bowl, will do, or a lithotomy scoop. But these masses are frequently very hard, almost stony, and often they can hardly be dislodged without previous softening, while those that lie still higher up in the canal are out of reach altogether. The removal of these must be achieved by enemata injected high up into the bowel by means of a long tube. These injections must be frequently repeated, and it may be necessary to play a stream from an enema upon the hardened collections for a long

time. But although the clearing out of the canal may be very troublesome, we believe it can always be effected by the careful use of a scoop for such masses as may come within reach, and of enemata; these may be copious ones of warm water, or, in more obstinate cases, of warm olive oil. Again, to about a pint of the oil an ounce of turpentine may be added. The tube of a stomach pump will do in the absence of a special apparatus for the administration of these enemata.

The intestine will be left in a very atonic state for a long time after the fæces have been removed, and a recurrence of the condition must be guarded against by the frequent use of simple or astringent enemata, vegetable or saline purges, and the like. Often much good is effected by shampooing and kneading the abdomen, especially if flatus be the most prominent symptom.

Acute Abdominal Lesions.—Apart from the previously described condition of intestinal obstruction, and apart also from the various injuries that may result from blows or crushes of the abdomen, there remains an important group of cases which present symptoms of an acute abdominal catastrophe. The chief causes of this condition are acute appendicitis, perforation of a gastric or duodenal ulcer, rupture of a pyosalpinx or an extra-uterine gestation. It is often impossible in the early stages of a case to make an accurate diagnosis, but it is very essential to recognize the important features which denote its severity, and the routine examination and course of treatment that are to be adopted until some definite conclusion can be arrived at.

In the first place it must be remembered that the three colics—renal, biliary, and intestinal (lead)—may all present features which closely simulate those of a more serious lesion; and care must be taken as far as possible to eliminate these confusing conditions.

Again, the gastric crises in tabes are sometimes so acute that a gastric perforation is simulated; and, lastly, it has been repeatedly pointed out that pulmonary diseases, such as pneumonia and pleurisy, may present a train of signs and symptoms closely simulating appendicitis. Ptomaine poisoning must also be considered.

It will be obvious, therefore, that in any given case admitted during the earlier stages of an acute disease a very careful examination will be required.

1. The urine must be systematically and carefully examined for blood, albumin, and crystals.
2. The conjunctivæ must be examined for signs of jaundice.
3. The patient's occupation should be noted, and lead-poisoning excluded.
4. The knee-jerks are to be tested, and other signs of tabes looked for, in a suspicious case.
5. The lungs are to be very carefully examined.
6. The presence or absence of any vaginal discharge is to be noted; also inquiries are to be made as to any irregularities or peculiarities

with regard to menstruation, especially in those cases where the lesion appears situated in the pelvic region.

7. A rectal and, if necessary, a vaginal examination should be made.

Having carried out this investigation with as little disturbance of the patient as possible (it must be left to the discretion of the house surgeon to recognize when vaginal or rectal examinations are best omitted), the next step is to consider carefully the condition of the abdomen and of the patient generally.

After perforation of the intestinal tract there is usually a considerable amount of shock. This may pass off in a few hours, and the observer must not be misled by the fact that when he is called to the patient the temperature may be normal and the pulse 70 to 80. As the case is watched the temperature will be seen to rise unless profound shock is present, and the pulse-rate will increase. *This is a most important point.*

The general aspect of the patient is suggestive of some grave condition. The face is usually pale, and there is a slight contraction of the forehead, giving the so-called anxious or abdominal expression. The patient is usually in great pain, and is restless, turning the head from side to side, throwing up the arms, and placing the hands behind the head. The body is kept still. The patient usually lies on the back, and *does not roll about or writhe* in pain as in cases of biliary or renal colic. Vomiting may or may not be a prominent feature. The vomit should be inspected for evidence of blood.

On inspection, the abdominal wall will be found retracted, and will not move with respiration. When the hand is placed upon it the muscles feel hard and boardlike, and *they do not relax during the respiratory movements.* This is an observation of the greatest value. Some doubtful cases present signs closely similar to those of a perforated gastric ulcer ; there is a fair amount of rigidity, pain, etc. ; but a gentle pressure of the hand will often succeed in overcoming the rigidity, especially if the patient's attention is distracted, and the muscles may be felt to yield during inspiration.

The skin on the surface of the abdomen is hyperæsthetic, and the lightest percussion causes a further muscular spasm, and the patient flinches and complains of great pain. When light percussion elicits this sign, taken in conjunction with the other symptoms, it is diagnostic of peritonitis.

There may be evidence of free gas in the peritoneal cavity, as shown by loss of liver dullness ; or of free fluid, by an increased dullness in the flanks. These signs are not of much value, and the diagnosis of a perforative peritonitis must not depend upon their presence or absence.

Given a case where most of the above signs and symptoms are present, the house surgeon may conclude that he has some serious abdominal lesion before him that will, in all probability, require an immediate operation. He will, therefore, notify his surgeon, and make the necessary preparations.

Supposing, however, that the symptoms are not quite definite, he must watch the case, keeping in mind the importance of an increase in pulse-rate and the development of muscular rigidity.

He must undertake no active treatment. No food must be given, and no drugs. Above all, he must not give morphia. If the collapse is profound, he may transfuse the patient and inject strychnine hypodermically. For the relief of pain he may order a fomentation for the abdomen. Nothing further that he can do will be likely to benefit the patient, while the administration of morphia or other forms of treatment are certain to be injurious.

CHAPTER XLVII

ON THE TREATMENT OF CASES OF POISONING

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WE have now to consider the measures which should be taken when some one of the substances which are commonly used as poisons, or which may be so used, has been taken into the body in sufficient quantity to produce toxic symptoms. The following are the chief of these substances, and we will consider them in the order in which they are here given :—

General Poisons	*Irritant and Corrosive Poisons*
1. Alcohol	1. Carbolic, Oxalic, Sulphuric, Hydrochloric, Nitric and other — Acids
2. Ether	2. Corrosive sublimate
3. Paraffin oil	3. Arsenic
4. Opium	4. Antimony
5. Strychnine	5. Phosphorus
6. Belladonna	6. Caustic alkalis
7. Prussic acid	
8. Nitrobenzol	
9. Chloral	

Poisonous Foods

Shell-fish	Mushrooms

The general poisons vary too greatly among themselves to admit of any general description, and must be considered separately.

Acute Alcoholic Poisoning may be conveniently divided into *Drunkenness* and *Acute Alcoholism with insensibility or coma.* The former is not in itself dangerous, and usually the best course to take with drunken men or women is to leave them to sleep off the effects of the alcohol. Nevertheless, even a moderate grade of drunkenness may be *dangerous in old or feeble people*, with degenerated tissues and weak circulation, for it may be the cause of a grave cerebral disturbance (sometimes of the nature of an apoplexy), or of a failure of the heart's action. The latter event must be particularly guarded against in cold weather, for, in consequence of the dilated condition of the arterioles of the skin, drunken people lose heat very quickly. Care must be taken, therefore, in thus leaving drunkards alone, that the conditions are such that there is no chance of their becoming dangerously cold.

Emetics.—It often happens, in the casualty department, that it is desirable to make a patient sober as soon as possible. For this purpose nothing is more effectual than a brisk emetic ; one of the safest and best is a dessertspoonful of powdered mustard in half a tumbler of warm water ; instead of this a solution of a dessertspoonful of common salt dissolved in half a tumbler of warm water may be given, or ½-dr. doses of carbonate of ammonia dissolved in water. For children 1 dr. of ipecacuanha wine is an excellent emetic.

The use of substances like tartar emetic, vinum antimoniale, copper sulphate, and apomorphine is to be avoided, since they are poisonous in themselves. Apomorphine is a very powerful cardiac depressant, and it is a dangerous drug to give in doses sufficient to cause vomiting. If possible, the stomach should be washed out with warm water, the contents being withdrawn ; for this purpose a soft tube should be passed and the proximal end of this attached to the stomach pump, or else to a piece of rubber tubing about three feet in length, at the end of which is a glass funnel. If the stomach pump is used, a little warm water is first passed in and the stomach contents are withdrawn. Fresh quantities of warm water are passed in and withdrawn in like manner until the liquid comes away fairly clear. The rubber tubing and funnel can be used in a similar manner : warm water being poured into the funnel, which when raised allows the water to pass into the stomach ; on lowering the funnel the gastric contents can be siphoned away, and thus the stomach washed out.

Faradism.—For the common occurrence of a drunken and disorderly person being brought to the hospital, and refusing to give his or her name and address, faradism, strong enough to produce painful contraction of the muscles, will generally prove effectual when the proceeding is really worth while.

Acute Alcoholism.—A short experience will enable the dresser to separate ordinary cases of drunkenness from other forms of poisoning, and we need not particularize its symptoms. It is undesirable also to attempt a hard-and-fast differential diagnosis between the higher grades of acute alcoholism and other grave conditions, but this is for a different reason, namely, because it is now not an alternative question, 'drunk or dying ?' but a positive statement, 'drunk, *and* dying.' Any patient who has swallowed enough alcohol to produce symptoms which may be confounded with apoplexy or any other severe illness must be considered to be poisoned, and to be in need of careful treatment. If brought to hospital he should be kept in until the severe symptoms have passed away, since it may be impossible to distinguish severe alcoholic poisoning from cerebral hæmorrhage. In these cases the condition of the circulation and respiration will be the best guide as to whether the patient may be left to recover from his stupor without further measures beyond those which are required for keeping him warm, or whether the *stomach pump* should be used ; but in most cases it will be best to wash the stomach out

with warm water, and this should always be done if there be any sign of failure of the heart's action, or if the breathing be suspiciously shallow. Alcohol may remain for a long time nearly unchanged in the stomach, and should therefore be removed, to prevent further absorption. In extreme cases, artificial respiration may be called for.

In acute alcoholic poisoning, as distinguished from simple drunkenness, if the stomach tube be not at hand, emetics may be used, but as it is undesirable to irritate further the already injured stomach, preference should always be given to washing out if possible. This irritable condition of the stomach should always be kept in mind in the treatment of the case after the acute stage has passed.

In acute alcoholic poisoning, after withdrawing the contents of the stomach or after the use of an emetic, about a pint of strong warm coffee should be given. The patient should be kept warm, and if there is heart failure, 5 min. liq. strychninæ may be given hypodermically, and repeated if necessary.

The diagnosis of alcoholic poisoning may be made with certainty by an analysis of the urine passed, or by an analysis of the blood, a sample of blood (10 c.c.) being taken from a suitable vein in the arm. The percentage of alcohol found is a good indication of the amount of alcohol consumed, and is one of the most certain tests of alcoholic poisoning.

Ether.—This form of intoxication is hardly known in England, but attention has been called to its frequent occurrence in some parts of Ireland. As a result of inhalation, it is of daily occurrence in all hospitals. When it is swallowed, its effects nearly resemble those of alcohol, but the period of excitement is more marked, and that of stupor less so. Its treatment does not differ from that of alcoholic poisoning.

Paraffin or one of the so-called mineral oils may be taken accidentally or with suicidal intent, and when swallowed produces flushing and excitement, followed by drowsiness. In these cases the major part of the oil is generally vomited spontaneously, but the stomach tube should in all cases be used, or failing that, an emetic should be given.

Opium Poisoning, or Poisoning by its Alkaloids, is very common, and is becoming more so, not from any increase of suicide by this means, but from inadvertence occurring amongst the growing class of people who have acquired the habit of administering the drug to themselves.

When opium is taken for suicidal purposes, laudanum is generally employed, and it often happens that the suicide swallows a very large quantity. This very frequently leads to failure of the attempt, through the active vomiting which is set up.

The Symptoms of opium poisoning are generally distinct enough. The slow shallow respiration and feeble fluttering pulse, the pallid, almost livid skin, covered with a cold sweat, the obstinate drowsiness

or profound stupor, and above all, the fixed contracted pupils, are sufficient evidence of the condition, even without any external or circumstantial proofs.

Treatment.—In this condition the respiratory centre is the part in greatest danger of striking work, and it must be kept going until the poison has been eliminated.

If the poison has been taken by the mouth, the stomach should be immediately washed out by means of the soft tube, as described above, and the contents withdrawn. If no stomach tube is available, an emetic will be necessary (*see* above, under 'Alcoholic Poisoning'). As soon as the contents of the stomach have been removed, a solution of permanganate of potash should be given as an antidote. Two ounces of the liq. potass. permang., B.P., diluted with 20 oz. of water, or 10 gr. of potassium permanganate crystals dissolved in a pint of water, are suitable quantities for administration. It is most important that the respiration of the patient be kept up ; thus ammonia vapour should be applied to the nostrils in the form of smelling-salts, and in severe cases artificial respiration is always to be resorted to. Faradic stimulation of the phrenic nerve is useful, and oxygen should be administered in severe cases.

Both atropine and strychnine are useful antidotes in opium poisoning, and should be administered hypodermically. Thus an injection of liq. strychninæ 6 min., and liq. atrop. sulph. 3 min., should be given in a severe case at once. After half an hour to an hour the stomach should be again washed out, and about a pint of very strong warm coffee introduced, or if no stomach pump is available, the coffee is given without removal of the gastric contents. The patient must be kept warm, and the respiration kept going by the above means. Hypodermic injections of strychnine 3 min. every two hours should be continued until the breathing improves. In severe cases of opium poisoning it is unwise to walk the patient about, as this often leads to heart failure.

When improvement has once commenced, it is generally continuous. The pupils may remain contracted for a long time, but when the respiration and circulation appear to be well established, and the patient is able to keep himself awake, the best treatment will be warmth in bed, when natural sleep will probably soon come on and may be encouraged. The patient should be watched, however, lest the respiration should again begin to fail and other symptoms of poisoning redevelop. It is important also to keep a close watch on the pulse and condition of the heart, since attacks of heart failure are common after the patient has apparently recovered from the symptoms of respiratory failure. Rest in bed for a few days is essential. Hypodermic injections of strychnine should be continued for two or three days, and ammonia and digitalis given by the mouth in a suitable mixture. Alcoholic stimulants seem to be hurtful in all stages of the poisoning.

Strychnine.—This alkaloid is a common ingredient of 'vermin powders,' 'beetle paste,' and the like, so that strychnine poisoning by misadventure is not at all infrequent. The symptoms of this condition may be mistaken for those of acute tetanus, but this error can hardly be made if attention be carefully given to the case for a short time. The condition is, of course, a 'tetanus' in both cases; but in that of the poisoning, the rapid development and acuteness of the attack, the universality of the convulsions, as opposed to the almost invariable spreading from the neck and jaw muscles in the ordinary tetanus, the nearly complete relaxation in the intermittent periods, and the fact that the duration of the whole attack is to be measured by hours—all these will enable a diagnosis to be made with almost absolute certainty. It is stated that in strychnine convulsions consciousness is usually retained. This is by no means always the case, since sometimes during the convulsions the patient is unconscious and the condition resembles an epileptic fit ; however, between the convulsions consciousness usually returns, while in the 'status epilepticus' of epilepsy the patient remains deeply comatose. In a case presenting severe convulsions where strychnine poisoning is suspected, careful inquiries should be made as to the taking of drugs, medicines, food, etc., since the symptoms are usually rapid in onset. The convulsions of acute meningitis, uræmia, and cerebral irritation from local lesions are distinguished by the marked associated symptoms, and by the less sudden nature of the onset.

Symptoms.—In strychnine poisoning there is a very short period of abnormal restlessness, quickly followed by a general trembling, and then a general convulsion occurs, with complete opisthotonos, and marked 'risus sardonicus' and cyanosis. In half a minute, or a minute, the spasm relaxes, and there is a period of exhaustion and respite, to be succeeded, on the slightest irritation or apparently without any cause, by a similar storm of reflex contraction. If death occurs, it will generally be from asphyxia or exhaustion, and will very often take place in less than an hour. If the dose has not been a fatal one, the convulsions will gradually diminish in frequency and force.

Treatment.—The main reliance must be placed upon inhalations of chloroform, and when the patient is under the anæsthetic the stomach should be washed out (*see* above) and large and frequently repeated doses of chloral hydrate and bromide of potassium given. Chloral hydrate may be given hypodermically in 5-gr. doses dissolved in water, and frequently repeated. Nitrite of amyl may be inhaled, and artificial respiration performed if possible. The administration of oxygen is of service in severe cases. If by any means the first few hours can be tided over, hopes of recovery may be fairly entertained.

Belladonna Poisoning is generally accidental, as from eating the berries of the deadly nightshade (*Atropa belladonna*), swallowing belladonna liniment (which contains spirit and camphor in addition to belladonna), or glycerin and belladonna, or some preparation

containing atropine or belladonna, or through some similar mistake. The *symptoms* are very characteristic. The pupils are widely dilated, and the skin capillaries injected, producing a rash like that of scarlatina. There is much cerebral excitement ; the delirium is generally chattering and restless, but may be extremely violent. The mouth is always parched, the skin very dry, and the temperature often raised.

Treatment.—*Emesis* must be produced by the stomach tube, or by a suitable emetic (*see* under 'Alcoholic Poisoning'), and following this, stimulants given in the shape of alcohol or ether, as well as strong tea or coffee, which are also useful from the tannin they contain. Artificial respiration may be necessary in very severe cases, and in others external stimuli, such as douche, faradization, etc.

Both morphia and chloral have an antagonistic action to atropine, but this is in neither case so distinct as that of pilocarpine. Tabloids containing from $\frac{1}{10}$ gr. to $\frac{1}{2}$ gr. of the nitrate of pilocarpine are now procurable, and are very convenient when it is desirable to use the drug in an emergency. One-third of a grain of nitrate of pilocarpine in solution should be given hypodermically, and repeated every two hours until the skin becomes moist. In cases where there is much delirium, morphia hypodermically in $\frac{1}{4}$-gr. doses of the tartrate may be substituted for the pilocarpine. Hot coffee should be given by the mouth. The patient should be kept warm, and oxygen administered if there is collapse ; artificial respiration may be necessary in severe cases.

Retention of urine is common in these cases, calling for the use of the catheter.

Prussic Acid Poisoning.—The action of hydrocyanic acid is so intense that death is often almost instantaneous, or there may be just time enough for a cry of agony. Even in less acute cases the symptoms come on within a few seconds. There is first respiratory difficulty, and then a period of violent convulsive movements, which are general throughout the body but especially affect the expiratory muscles. Vomiting and involuntary urination and defæcation occur. This stage is followed by a period of calm, with rapidly deepening paralysis and cyanosis. This usually is quickly followed by death. In fact the whole attack is one of acute asphyxia.

Treatment.—Should there be time for any attempts at restoration, an emetic should be given, or the stomach tube used, if it can be employed *at once*, and then ammonia on a handkerchief, as strong as can be borne by the patient, should be inhaled, and other stimulants freely given by the mouth if they can be swallowed ; if not, then brandy and ether should be given hypodermically. Stimulant enemata may also be made use of. Alternate douches of cold and hot water are powerful stimuli to respiration, and strong faradization should always be applied if possible. Artificial respiration will most probably be called for as soon as the convulsive stage is over, and must be persevered in, although the condition may seem to be almost hopeless.

Atropine should be given hypodermically, e.g., 4 min. of the liquor atrop. sulph. B.P., immediately, and should be repeated if necessary.

The materials used for prussic acid poisoning are usually either impure bitter almond oil, or the pharmacopœial or 'Scheele's' acid, or potassium cyanide, which is used by photographers, or by gardeners to destroy wasps and hornets in their nests.

Nitrobenzene.—This is an oily liquid smelling of almonds ; it is sometimes known as commercial oil of bitter almonds. If taken internally, symptoms commence in a quarter of an hour to two or three hours. Headache, vomiting, marked cyanosis, and giddiness, with much collapse, are the characteristic features of a case, and if much poison is absorbed, coma is likely to supervene.

Treatment.—The stomach should be thoroughly washed out or an emetic given at once. Stimulants and external warmth, liq. strychninæ 3 min. every hour for a few hours. Oxygen inhalations and artificial respiration may be necessary.

Chloral.—The symptoms resemble in great measure those of opium poisoning, but the fixed contraction of the pupils is absent, and the circulation is affected quite as much as is the respiration.

Treatment.—The stomach should be washed out at once, or an emetic given. The patient must be kept warm. A pint of hot coffee should be given by the mouth. Injectio strychninæ hypoderm. 5 min. should be given at once and repeated in half an hour if necessary. Oxygen inhalations are beneficial, and artificial respiration will be necessary in a severe case. The subsequent treatment is directed against the heart failure which is likely to supervene (*see* above, 'Opium Poisoning').

Irritant and Corrosive Poisons may conveniently be grouped together, for the symptoms of the latter differ from the former only in their greater intensity. Moreover, many of the substances in our list are irritant poisons in weaker solutions, and corrosive poisons when concentrated. In most cases the local effects are so marked that any constitutional results of their absorption are unnoticed.

Symptoms.—The following is the general sequence of events after an irritant poison has been swallowed. There is first a burning metallic taste in the mouth and throat, and then a sense of intolerable pain referred to the chest, behind the sternum (heartburn). This is followed by increasing general abdominal pain, so that the legs are drawn up, as in peritonitis, and the belly becomes tumid. Vomiting is almost invariably present, and there is generally great thirst.

If the poison has been taken in a quantity insufficient to cause speedy death, and if it be *irritant* only, and not corrosive, the above are the chief symptoms. In less severe cases these may, with appropriate treatment, be subdued ; if, however, the dose be a fatal one, the symptoms of irritation will quickly be followed by dyspnœa and increasing collapse, and the patient appears to be in the algid stage of cholera, and this will continue until death by syncope occurs.

But if the substance be truly *corrosive* in its action, such as one of the concentrated mineral acids, the symptoms are even more severe, and run a much more acute course ; it is probable that no recovery has ever taken place after such a poison has been swallowed so that any considerable quantity has passed into the stomach, although instances are common of great damage to the throat and œsophagus being followed by recovery ; or, we should rather say, by recovery in the first instance, for generally the consequent cicatrization has led to contraction and stricture.

The damage to the lips and throat is the first and most prominent symptom, and gives the measure of the extent of the corrosion of the parts lower down. The corners of the mouth may be excoriated, and the tongue and palate covered with a whitish coat of slough, 'like a coat of white paint,' if sulphuric or hydrochloric acid or corrosive sublimate has been used ; or with a yellow stain in the case of nitric acid.

In the presence of these signs of corrosion a very few minutes will decide whether the poison has been really swallowed. If so, the symptoms which have just been detailed will develop, but more rapidly and more acutely. The *stage of collapse* is reached more quickly, and there are signs of actual corrosion of the viscera. The vomit contains shreds of sloughing mucous membrane or, it may be, casts of whole sections of the œsophagus. The abdomen becomes enormously distended with gas. The dyspnœa and dysphagia are both intense, and death usually occurs within a few hours.

Treatment.—In many respects the treatment of poisoning by irritant and corrosive substances is common to them all ; and again, with regard to many, there are some particular antidotal drugs, or some special measures to be taken or avoided.

With corrosive poisons, such as sulphuric, hydrochloric, or nitric acids, and the caustic alkalis, it is unsafe to use the stomach pump or to give emetics, as there would be great risk of perforation. The appropriate antidote should be given freely, and by it the poison is readily neutralized. In the case of the irritant poisons, such as oxalic acid, carbolic acid, and corrosive sublimate, which are only to a slight extent corrosive, the appropriate antidote should be given at once, and then the contents of the stomach may be carefully withdrawn and a fresh quantity of antidote introduced.

As soon as the stomach has been relieved of the poison, raw egg-albumen, milk, barley-water, arrowroot, or whatever mucilaginous fluid can be most readily procured, should be given. Egg-albumen, raw, is probably the best of all in all cases, as well as having a special action on corrosive sublimate. Salad oil may generally be given with good results, except in the case of phosphorus poisoning. The rest of the general treatment of irritant poisoning will be directed towards the symptoms of peritonitis and collapse. The pain must be subdued with full doses of opiates. The warmth of the body must be main-

tained, and the other signs of shock combated by such stimulation as the inhalation of ammonia or nitrite of amyl, the subcutaneous injection of liq. strychninæ or of ether and brandy, stimulant enemata, faradization of the extremities, etc. Morphia by hypodermic injection will also generally be indicated.

Special Points in the Treatment of particular Irritant and Corrosive Poisons.

1. *Irritant and Corrosive Acids.*—These comprise sulphuric, nitric, hydrochloric, oxalic, and carbolic acids ; the symptoms in the case of the first three will be similar, and in accordance with those results of swallowing any corrosive fluid which have just been described. The acuteness of the symptoms will vary directly with the strength of the solution, and inversely with the quantity of food in the stomach. In all, if a strong solution be actually swallowed, the symptoms will be of the most urgent kind and will be rapidly fatal if not at once counteracted, so that time is of the utmost importance. The stomach pump may not safely be used. The marking in the case of nitric acid is yellow, and the vomit possesses a nitrous smell. In sulphuric and hydrochloric acids the lips and mouth are whitish, and the vomit dark or black, containing shreds of mucous membrane.

The Treatment lies in diluting and neutralizing the acid as quickly as possible, so that all remedies should themselves be copiously diluted. Oxide of magnesia and water, lime-water (the saccharated is the best), whiting and water, chalk and water, ordinary washing soda, or the bicarbonates of soda or potash, in solution, are all useful alkaline remedies. Some of them will almost certainly be at hand in any given case, and it should always be borne in mind that the antidote should be given as soon as possible.

In addition to alkalis, milk, olive oil, and the other demulcents mentioned above are all useful.

After administering the antidote in full amounts to neutralize the acid, it is best to avoid giving food by the mouth, but to give rectal injections of warm saline, and to keep the patient warm and guard against collapse as far as possible. Morphia hypodermically will be called for to relieve pain, and strychnine hypodermically for the collapse, with the addition of brandy if necessary.

In poisoning by *Oxalic Acid* or by *Salts of Sorrel* (the acid oxalate of potash) the main special point to bear in mind is that the alkaline oxalates are soluble and poisonous, so that chalk, whiting, or lime-water must be used to neutralize the acid, and not soda, potash, or ammonia, or the carbonates of any of these. Oxalic acid poisoning is rather common, and is frequently suicidal. The symptoms are those already detailed, save that collapse is often disproportionately marked, and that death may be very speedy.

The best antidote to give is a mixture of whiting with saccharated lime-water. After giving this the stomach may be carefully washed out in a few minutes. Strychnine, and also brandy or spirits of ether,

hypodermically, must be given to counteract the collapse. The patient must be kept warm, and oxygen given, and brandy by the mouth if necessary.

Carbolic Acid is now perhaps the commonest of all forms of poisoning by misadventure, and is also used for the purposes of suicide. Its corrosive action is, in concentrated solutions, very conspicuous, but the destruction does not extend deeply into the tissues. The mouth and jaws are usually covered with a white, leathery pellicle. The symptoms are those of poisoning by any corrosive fluid, but pain is less intense than in the case of other acids, owing to the anæsthetic action of the acid on the nerve terminations. The symptoms are less acute than in the case of the corrosive acids, but collapse is likely to occur early and coma to supervene. Suppression of urine may occur.

Treatment.—Saccharated lime-water should be given freely (one or two pints), since this converts the phenol into an inert compound (ordinary lime-water has the same effect, but more is necessary). The stomach should be washed out with warm water, or with the same alkaline solution, three or four times, half a pint or so of the solution being afterwards left in the stomach. In the absence of the stomach pump, vomiting must be produced by mustard and water. Later on, demulcents, such as barley-water, olive oil, etc., may be given, or an ounce of castor oil.

Shock is often very marked, and must be treated by frictional warmth, ammonia, etc., as before stated. Hypodermic injections of strychnine should be administered, and oxygen inhalations.

The urine is often dark and scanty, and may be suppressed in acute carbolic acid poisoning. The carboluria is then a grave symptom, but it often happens in surgical cases that carbolic acid, not necessarily used in very large quantities, is absorbed and produces a similar inky urine. Some patients seem to be especially susceptible to this mild form of carbolic acid poisoning, which apparently does them no harm provided the source of the poison is removed as soon as possible.

'Lysol' is a saponified solution of cresol. Its poisonous effects are similar to those of phenol or carbolic acid, and the treatment is the same.

2. For *Corrosive Sublimate* (perchloride of mercury), the acid nitrate of mercury, etc., albumin in any shape (even gluten of flour is better than none, but raw white of egg is best) should be freely given, as an insoluble albuminate is thus formed. Emesis should be encouraged by warm water or mustard and water, if vomiting be not active without such aid. If the solution has been concentrated, the stomach pump must only be used with great care. Afterwards the patient must be kept warm, and morphia administered hypodermically, with starch and opium enemata if necessary to allay the purging which often occurs. Strychnine hypodermically may be required for collapse. The late symptoms of corrosive sublimate poisoning are suppression of urine and acute ulcerative colitis, both of which must be treated

symptomatically. A very guarded prognosis is necessary in cases when the symptoms of irritant poisoning have subsided, since the late symptoms may develop after 3 to 6 days from the taking of the poison.

3. *Arsenical Poisoning* is generally effected by arsenious acid (white arsenic), sometimes given with criminal intent. The symptoms come on usually in one-half to one hour after taking the poison. The vomiting and purging resemble at first an intensely violent bilious attack ; afterwards the symptoms are more like acute cholera, and the diagnosis is often obscure. The emesis must be encouraged, while the stomach should be thoroughly washed out with warm water, and the contents removed. Freshly precipitated ferric hydrate should be given as an antidote : this may be prepared by diluting half an ounce of the tincture of perchloride of iron with half a tumblerful of water and adding half an ounce of a strong solution of carbonate of soda (until the mixture is definitely alkaline) ; the precipitate is well stirred up in the liquid, and the mixture given at once. In place of the ferric hydrate, drachm doses of the solution of dialysed iron diluted with water may be administered. Saccharated lime-water freely given might be of service in the place of the iron preparations. For the collapse which follows, warmth and stimulants, e.g., brandy, and strychnine hypodermically, are necessary. Morphia hypodermically will be necessary for the diarrhœa and vomiting, and starch and opium enemata will relieve the tenesmus and purging.

If the diagnosis of the acute form of this poisoning is not generally easy, that of chronic arsenical poisoning is always difficult ; but the latter condition does not fall under the heading of emergencies.

4. *Antimony* (*Tartar Emetic*).—The symptoms come on soon, and generally the vomiting is so violent that the whole of the poison is soon ejected. If not, the symptoms resemble those of arsenical poisoning, but there is more depression. The treatment is the same as in arsenical poisoning ; but in addition *tannin* should be given in the form of very strong tea or coffee, or by means of preparations of oak or cinchona bark, or of tannic acid itself.

5. *Phosphorus*.—This is usually taken in the form of beetle paste, or rat paste, or sometimes by swallowing the heads of lucifer matches. In these cases the symptoms declare themselves quickly after the poison has been taken, and are generally prolonged over days, or it may be weeks. The prominent symptoms are great thirst, heart-burn, and violent vomiting, the vomit being phosphorescent in the dark and frequently black and grumous from altered blood, and the breath smells strongly of the poison.

The result will mainly depend on whether the vomiting be sufficiently active to prevent an absorption of a really poisonous amount. If the quantity absorbed be large, the symptoms remain acute ; hæmatemesis and bloody purging are often present, with cramps, and finally coma. But if only a small, but still poisonous, quantity has been taken (say $\frac{1}{2}$ to 1 gr.), after the first indications of irritation have passed

over, the symptoms usually subside for a day or two, and then symptoms like those of acute atrophy of the liver with jaundice begin to declare themselves. The jaundice deepens, and a comatose typhoid condition, with delirium, generally ends in death in a few days, although in some of the milder cases recovery may take place. The early treatment of the poisoning does not differ from that of other irritants, save that *oil*, in which phosphorus is soluble, *should never be employed* with the idea of soothing the intestinal mucous membrane. After the stomach has been emptied of its contents, either naturally or with the stomach pump, permanganate of potash solution (*see* 'Opium Poisoning') should be given by the mouth, or Sanitas in 4-dr. doses well diluted, or the French oil of turpentine in doses of ½ dr. suspended in mucilage and frequently repeated. These antidotes contain nascent oxygen, which will convert the phosphorus into the non-poisonous phosphoric acid. The subsequent treatment is similar to that of arsenical poisoning in its later stages. *Chronic phosphorus poisoning*, phosphorus necrosis, etc., are not here discussed, for they do not occur as emergencies.

6. *Caustic Alkalis and their Carbonates.*—This form of poisoning is rare, but potash or soda lye is sometimes taken. The symptoms are those of ordinary corrosive poisoning, except that violent purging is generally a prominent symptom. In the treatment the use of the stomach pump must be avoided. Weak acids, such as vinegar and water, or any of the dilute non-poisonous acids, such as citric or tartaric acids, 4 dr. dissolved in a pint of water, should always be given. Subsequent treatment as for corrosive acids in the later stages.

Poisonous Foods. *Shell-fish.*—A form of acute gastro-intestinal irritation, often so severe as to justify the term 'poisoning,' is not infrequent as a result of eating shell-fish, especially mussels.

In the treatment, an emetic should be given in the first place, and afterwards a full dose of castor oil with 20 min. of laudanum. Warmth and stimulants are necessary for the collapse. Morphia hypodermically should be given for the vomiting and diarrhœa, and a starch and opium enema if necessary.

Mushroom poisoning should not go without mention. Most fungi, edible or inedible, may produce, if improperly cooked, symptoms of a mild degree of irritant poisoning, similar to those which have been mentioned, and may be treated in a similar way. But cases of true *muscarine* poisoning exhibit a much higher grade of toxic symptoms. The fungi which contain muscarine or some similar alkaloid are not very numerous in England, the principal one being the fly fungus (*Amanita muscaria*). When the more actively poisonous fungi have been eaten, as a rule great cerebral excitement is caused, in addition to the more strictly irritative effects on the alimentary tract.

In the antagonism between *muscarine* and *atropia* we have perhaps the best example of this mode of the physiological action of drugs. Digitalis also, though in a less degree, is antagonistic to muscarine. Whenever, therefore, the symptoms of mushroom poisoning are grave,

and especially if there be delirium or mania, atropine should be given, say 3 to 5 min. of the liq. atropinæ by the mouth, or 2 min. subcutaneously, or as an alternative treatment, full doses of the tincture or infusion of digitalis may be administered. In other respects the treatment should consist in removing the poison from the alimentary tract as soon as possible, by means of the stomach tube or an emetic, and by the administration of an ounce of castor oil as a purgative. Where there are marked gastro-intestinal symptoms, morphia hypodermically should be given, and starch and opium enemata ; warmth and stimulants are necessary for the collapse.

CHAPTER XLVIII

HEAD INJURIES

INJURIES to the head and brain are among the most important cases with which house surgeons have to deal. There is no doubt that it is impossible always to estimate the amount of damage sustained, nor is it possible, even in cases of undoubted severe injury, to diagnose the exact seat and extent of the mischief in every case. It follows then that it is imperative to examine these cases with the most scrupulous care, to consult with one's colleagues in case of doubt, and to treat as severe every case that is not obviously simple and uncomplicated. This may lead to the admission of some cases unnecessarily, but this is far better than the overlooking of a fracture of the base and the consequent discharge of a patient who is in peril of his life. It is particularly necessary to train oneself to avoid prejudgement in 'unconscious' cases. In the casualty department we see so much drunkenness that we may be unconsciously biased in favour of a diagnosis of alcoholism, especially if we get our first impressions from the police officer in charge of the ambulance, who has, usually, only one idea as to the cause of unconsciousness, and is willing to express it firmly and without qualification. We must remember, too, that many unconscious patients fall at first into the hands of the modern 'Good Samaritan,' who, as a rule, props his victim in a sitting position against the nearest railings and pours brandy into his mouth, thus giving to the patient's breath the alcoholic odour which is looked upon as diagnostic by the careless or inexact observer. The differential diagnosis of 'coma' cases will be discussed in parallel columns later in the chapter.

INJURIES OF THE SCALP.

The importance of scalp wounds lies in the possibility of their association with some injury to the bones of the skull. The presence of loose cellular tissue between the aponeurotic layer and the pericranium allows of a considerable degree of movement of the scalp on the underlying bone, and this minimizes the effect upon the bones of the skull of any but direct blows. The scalp is very well supplied with blood, with the result that comparatively trifling injuries may lead to a considerable hæmorrhage.

Contused Wounds lead to extravasations of blood : (1) Between the layers of the scalp itself ; (2) Beneath the aponeurosis ; or (3) (in

children) beneath the pericranium. A hæmatoma in the first situation results from a direct blow, remains definitely circumscribed, and may be felt to move with the scalp. As the effused blood coagulates, the edges solidify sooner than the centre, and to palpation the impression is given of a raised hard edge, and a depressed centre simulating a depressed fracture. To differentiate between the two conditions, firm pressure should be made on the edge with the finger ; in the case of a hæmatoma the edge at the point of pressure will disappear, while of course the fracture will be unaffected.

Hæmatoma under the Aponeurosis results from glancing blows, and may be of considerable extent. Its importance lies in the possibility of infection, leading on to diffuse cellulitis.

Hæmatoma under the Pericranium is most common in children, forming the well-known cephalhæmatoma.

As the result of a blow, a wound of the scalp may occur which resembles closely an incised wound, but a close examination will show that the edges are bruised. In rare cases a blow on the scalp will cause rupture of the aponeurosis without a skin wound. It is often difficult to distinguish between such a condition and a fissured or depressed fracture of the vault.

Wounds of the scalp require particular attention for two reasons :–

1. They may be associated with a fracture of the skull, the fracture and the wound not necessarily coinciding in position or extent.

2. Owing to the impossibility of making the scalp surgically clean, the risk of suppuration must be remembered and drainage provided for. Nevertheless, every effort must be made, by shaving, scrubbing, and douching with antiseptics, to cleanse the wound—if necessary under an anæsthetic. On the whole, scalp wounds heal well, and sloughing is practically unknown however extensive the injury, owing to the abundant blood-supply.

FRACTURES OF THE SKULL.

Fissured Fractures of the Vault may be impossible to diagnose if not compound, the only sign being perhaps a linear tenderness. If there is an open wound, a fracture is easily recognized. It must not be confused with a suture, from which it differs in being straight, and occasionally blood is seen oozing along the course of the fracture. It must be remembered that a fissured fracture may extend into the base.

Depressed Fractures of the Vault are readily recognized, the only condition resembling them being hæmatoma (q.v.). The effect on the inner table is generally greater than that on the external, and for this reason *it is advisable to consider all depressed fractures, whether simple or compound, as possible operation cases.*

Fractures of the Base must be diagnosed by attention to symptoms rather than by direct examination of the seat of injury. The symptoms differ according as the fracture affects the anterior, middle, or posterior

fossa. They depend on the escape of blood and cerebrospinal fluid extracranially, the injury of meningeal vessels, or nervous lesions.

Extracranial Bleeding occurs from the *nose* as the result of fracture of the ethmoid (cribriform) plate in anterior-fossa fractures, and from the *ear* in middle-fossa fractures. At a later stage, hæmorrhage under the eyelids or conjunctiva occurs in anterior-fossa fractures, into the tissues over the mastoid process in middle-fossa fractures, and over the occipital region in posterior-fossa fractures. Fracture through the basilar process of the sphenoid bone may give rise to pharyngeal hæmorrhage. All these hæmorrhages are free, in distinct contrast to the bleeding that may occur as the result of a purely local injury, e.g., rupture of the membrana tympani or injury to the cartilage lining the meatus auditorius externus. In addition, cerebrospinal fluid may escape, and its presence is diagnostic of basal fracture. It possesses the following characters : it does not give the reaction for albumin, but contains sodium chloride and a substance (pyrocatechin) which gives the sugar reaction with Fehling's solution.

Intracranial Bleeding.—The commonest meningeal vessel that is injured is the middle meningeal artery in or near its passage through the foramen spinosum or in its groove on the temporal bone. Injury to this vessel gives rise to the well-known symptoms of compression due to extradural hæmorrhage, with the characteristic 'interval' between concussion and compression. More rarely, the cavernous, longitudinal, or lateral sinus may be wounded, giving rise to their characteristic signs.

Injury to the Nerves occurs near their foramina of exit. The most commonly affected is the facial, then the abducens. Often groups are affected : the 5th and 3rd together ; the 6th, 7th, and 8th ; or the 9th, 10th, and 11th.

The following table shows in parallel columns the symptoms of basal fracture :—

SYMPTOMS OF BASAL FRACTURE.

SYMPTOM	ANTERIOR FOSSA	MIDDLE FOSSA	POSTERIOR FOSSA
Extracranial hæmorrhage, and escape of cerebrospinal fluid	(*a*) From the nose (*b*) Into the orbit (later)	(*a*) From the ear (*b*) Over mastoid (later)	(*a*) Into the pharynx (*b*) Into the cellular tissue of the occipital region (later)
Intracranial hæmorrhage		(*a*) Middle meningeal artery (*b*) Cavernous sinus	Lateral sinus Occipital sinus
Injury to the nerves	Olfactory Optic	3rd and 5th 6th, 7th, and 8th	9th, 10th, and 11th

COMPLICATIONS OF HEAD INJURIES.

There are three main complications of head injuries affecting the brain which may be described : *Concussion, Contusion or Laceration,* and *Compression.* Each of these conditions gives rise to symptoms peculiar to itself, but it must be understood that it is often difficult to draw a definite distinction between any two of them, to say when concussion merges into laceration, or either into compression.

Concussion is the name given to the state of unconsciousness immediately following upon a blow on the head. The patient is, in a word, stunned. The symptoms appear immediately on receipt of the injury, and two stages are recognized : (1) The stage of collapse ; (2) The stage of reaction.

In the Collapse Stage there is insensibility of varying severity. The patient can generally be roused, but relapses into insensibility. The pupils are equal, often contracted, and react to light. The pulse is slow and weak, the respirations are slow, shallow, and irregular. The muscles are relaxed, but there is no actual paralysis ; the reflexes are present. There is incontinence of fæces and urine. There is a subnormal temperature.

When Reaction occurs, there is a gradual return to consciousness ; vomiting may occur, but does not persist. The pulse increases in rate and volume, and the respirations become deeper and more regular. The extremities become warmer, and the body temperature may rise to a degree or so above normal.

Contusion or Laceration gives rise to symptoms resembling concussion, but generally of greater severity, the period of unconsciousness being considerably prolonged. The symptoms are due to a venous extravasation from the cortical veins, and naturally present a less definite picture than is seen in an arterial hæmorrhage between the skull and dura mater. The typical symptoms may not appear for three or four days. If the laceration is in the sensori-motor area, clonic spasms may occur affecting certain groups of muscles, or, in more severe lacerations, paralysis may result. A group of symptoms apart from sensori-motor symptoms may occur, to which the name of *cerebral irritation* has been given. The patient lies curled up on his side, eyes closed, pupils contracted and equal, pulse slow and weak, and temperature subnormal. He can be roused, but resents interference, and will often keep his eyes tightly closed if an examination of them is attempted. The urine and fæces are passed into the bed. This condition may last for several weeks, but tends to recovery, though in areas other than the 'silent areas' permanent defects may result from the injury to the cortical centres. In the early stages of laceration a lumbar puncture will demonstrate the presence of blood in the subarachnoid space.

Compression due to pressure by blood extravasated between the brain and the cranial bones—generally from injury to the middle

meningeal artery (subcranial hæmorrhage)—comes on gradually, and steadily increases in severity as long as hæmorrhage is unchecked. In subcranial hæmorrhage, symptoms of concussion are present at first; but these pass off, the patient recovering consciousness, to relapse into a deeper unconsciousness as pressure on the brain becomes established. This 'interval' is the typical sign of compression. If the hæmorrhage be subdural or subarachnoid, the interval of consciousness does not occur. Here again a lumbar puncture is of value in diagnosis. The general condition is one of drowsiness passing into coma. The patient cannot be roused, and insensibility is complete ; the pupils are dilated and do not react to light ; if the pressure is unilateral, the pupil *on the side of the lesion* will be the more dilated at first, but in the later stages both pupils will be dilated and immobile. The pulse is slow, full, and heaving. This pulse is characteristic of compression, but in later stages it becomes quick, small, and irregular. Respirations are slow and deep ; owing to paralysis of the palate and buccinator muscles, stertor is present, and the cheeks are blown out with each expiration. In the later stages respirations become hurried, shallow, and irregular, and may imitate the Cheyne-Stokes type. There is general paralysis, though hemiplegia may be present in the early stages of a unilateral lesion where the clot presses on the motor area. Reflexes, superficial and deep, are lost. Incontinence of fæces occurs, and, owing to paralysis of the bladder, false incontinence of urine, i.e., retention, with overflow from the full bladder, is the rule. The temperature, at first subnormal, tends to rise in later stages, especially in cases terminating fatally. In unilateral pressure, the temperature of the side paralysed, i.e., the side opposite the lesion, is slightly raised. The differential diagnosis between concussion and compression is subjoined :—

Differential Diagnosis of Concussion and Compression.

	CONCUSSION	COMPRESSION
Onset	Sudden	Gradual
General condition	Can be roused	Cannot be roused
Pupils	Equal, react..	Dilated, immobile, perhaps unequal
Pulse	Slow and weak	Slow, full, heaving
Respirations ..	Slow, shallow, irregular ..	Slow, deep, stertorous
Muscles	Relaxed (functional paralysis)	Organic paralysis
Reflexes	Present	Absent
Rectum	Incontinence of fæces ..	Incontinence of fæces
Bladder	Incontinence of urine ..	False incontinence
Temperature ..	Subnormal	Subnormal, rising in late stages ; may be unequal on the two sides

General Considerations.—

1. All cases of suspected intracranial injury should be lumbar-punctured. If the brain is lacerated, the fluid may be almost pure blood at certain stages. In middle meningeal hæmorrhage, there may be no alteration in the fluid.

2. The deeper the unconsciousness, the graver the injury.

3. Temperature, blood-pressure, and pulse-rate should be taken and charted every half-hour.

4. The temperature is subnormal at first. If it rises later and continues to rise, the case will end fatally in 24 hours from laceration of the brain.

5. If the shock stage persists, death will occur in 24 hours from laceration or hæmorrhage.

6. In the average case, after the shock stage, the temperature rises to 102° or 103°, and then 'halts.' If this 'halt' is followed by a definite fall, the patient will survive ; if by a definite rise, he will die.

7. Treatment.—

a. In shock stage, no treatment but morphia. Operation definitely contra-indicated. No transfusion or anything else till the diagnosis is made.

b. After shock stage, with steadily rising temperature, decompression should be done, but prognosis poor.

c. After shock stage, if temperature keeps up, with slow pulse and high blood-pressure, decompression should be done.

d. In later stages with falling blood-pressure, rising pulse-rate, stertor, and Cheyne-Stokes breathing, nothing can be done.

TREATMENT OF COMPLICATIONS.

Concussion must be treated according to the stage at which the case is seen. In the first stage the condition is one of shock, and treatment must be on appropriate lines, viz., the patient placed in the recumbent position with the head low, and efforts made by the application of warmth, and in severe cases by stimulants, to counteract the circulatory depression. The traditional ice-cap should not be applied in this stage, nor should a purge be given, as both tend to depress. When reaction occurs, the patient must be kept very quiet, and must be constantly watched in order that the first signs of any further complication, such as compression, may be noted. A few grains of calomel should be administered, and a castor-oil enema, but the application of an ice-cap is inadvisable. In some cases a catheter has to be passed. The patient should be confined to bed until the pulse is steady and normal, and headache has quite disappeared.

Contusion and Laceration are treated on similar lines, but, speaking generally, the patient must be confined to bed for a longer period. There is rarely any necessity for operative procedures.

The treatment of **Compression** is from the first operative. The pressure must be relieved and the injured vessel secured. The methods

that have been adopted are trephining, venesection, and lumbar puncture. Of these, venesection may be unhesitatingly condemned, for while it may reduce the amount of hæmorrhage from the injured cerebral vessel, it will still further increase the cerebral anæmia which is the chief danger to life. Lumbar puncture is of value for diagnosis, but seems to have but little effect on the intracerebral tension, though occasionally one hears of cases where repeated lumbar puncture has been employed successfully.

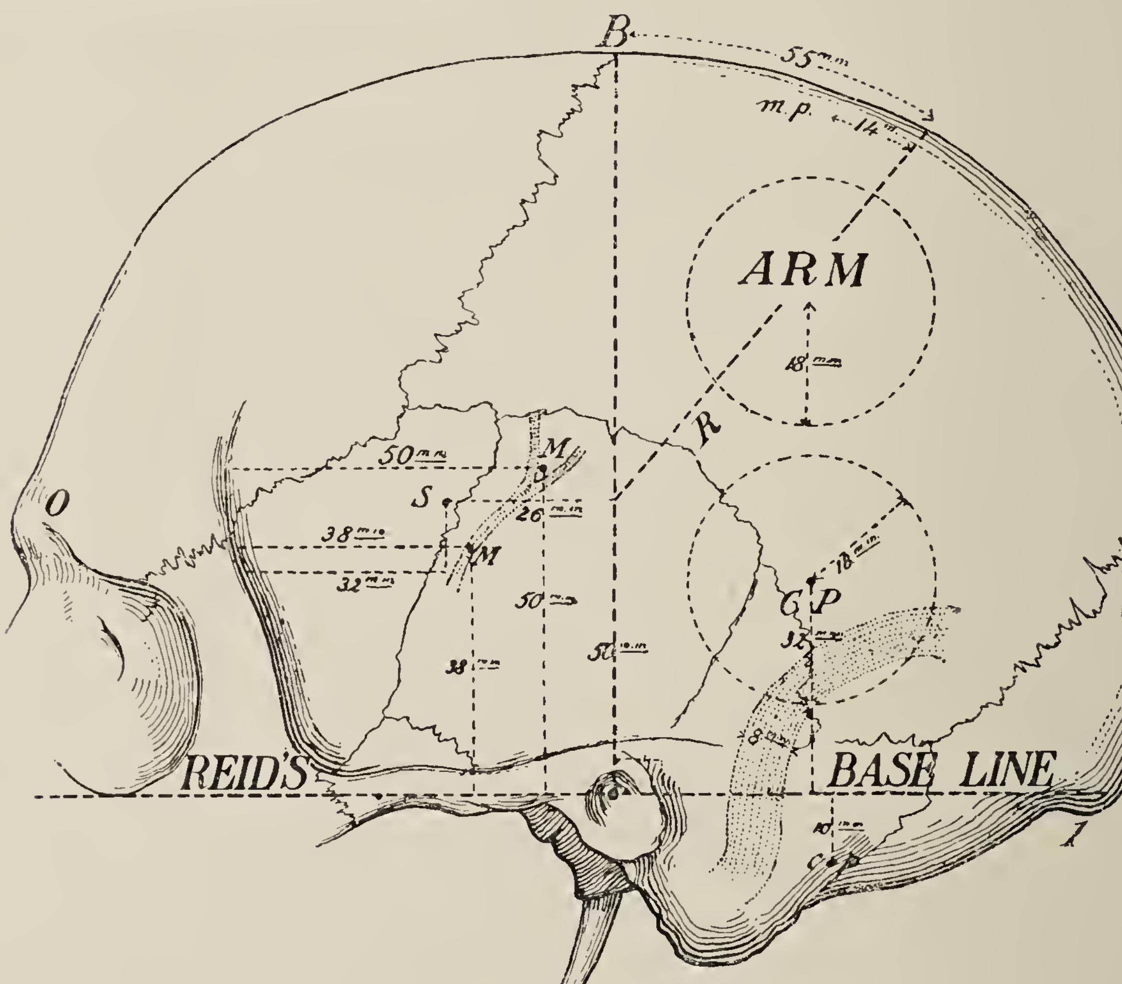

Fig. 303.—Surface Marking of Skull.

Compression may be due to extravasation of blood between the bone and the dura, between the dura and the brain, or in the brain itself. The extradural hæmorrhage is the most common and the most amenable to treatment.

Extradural Hæmorrhage generally results from injury to the middle meningeal artery, either as it passes through the foramen spinosum or in the groove on the temporal bone ; hæmorrhage from a venous sinus is much more rare, because the venous pressure is so low that the dura is not stripped up from the bone. The clot generally forms in the temporal region, but its exact position may be impossible to ascertain previous to operation ; indeed, it may be very hard to decide whether the lesion is on the right or left side. If focal symptoms occur, the diagnosis will be simplified, but these must be looked for early, before the onset of coma. As the extravasation is generally over the lower

rather than over the higher Rolandic areas, it is rare to find paralysis of the extremities, especially the lower limbs, unless a very large clot has formed. Dilatation of one pupil points to that side as the side of the lesion.

Operation.—The whole head should be shaved and prepared. A flap with its convexity upwards should be turned down from the temporal region, including the temporal muscle. The middle meningeal artery should be exposed at the point where it crosses the middle of the temporal fossa. It is easily reached here, and there is a better chance of securing it if it is injured low down than if a higher trephining is done. A simple surface marking is Vogt's "two fingers' breadth above the zygoma and a thumb's breadth behind the vertical process of the malar," a rough but effective marking of the main trunk. If the correct side has been chosen, the removal of the disc of bone will at once disclose the clot. This should be removed, and the bleeding vessel ligated or plugged. The depressed surface of the dura does not expand at once, so that the disc of bone cannot usually be replaced. If the dura is intact, hernia cerebri will not occur.

Operations for subdural hæmorrhage are rarely called for, nor are they justifiable unless there are symptoms of pressure on the medulla. The effusion of blood is generally basal, and the operation is performed more to relieve pressure than to arrest hæmorrhage. As little as possible should be done, but there is a definite risk of post-operative hernia cerebri.

Hernia Cerebri.—If a condition of intracranial tension exist as the result of tumour, sepsis, or whatever cause, and if an opening is made in the skull and dura mater, a prolapse of brain matter will occur through the opening, and this is known as a *hernia cerebri.* If, as the result of an injury, the soft parts covering the opening are deficient, the brain matter is exposed and a *fungus cerebri* results. A hernia cerebri is often made with intent in cases of cerebral tumour, and acts as a safety-valve in reducing intracranial tension, thus prolonging life, saving eyesight, and relieving headache. A hernia cerebri properly protected by intact soft parts is not a danger to life. On the other hand, a fungus cerebri may be a source of much embarrassment. It generally results from a compound fracture of the skull when the dura has been injured. The wound is infected, and a localized meningitis and encephalitis follow. As the result there is intracranial tension, and a protrusion occurs at the point of least resistance. The mass, which may reach a considerable size, consists chiefly of granulation tissue, with some necrotic nerve fibres and cells. While the fungus itself is not dangerous, there is a great danger in the co-existing meningitis and encephalitis, and many of these cases end fatally.

Treatment must be directed entirely to obtaining and maintaining surgical cleanliness. There is nothing to be gained by applying pressure, and shaving off the prominent portion is of very slight if any value. The possibility that the protrusion contains a horn of the

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lateral ventricle must be borne in mind, as injury to the ventricle increases the risk of meningitis. As granulation tissue forms the bulk of the tumour, the application of pure spirit is advisable, and this is also a valuable antiseptic. Frequent irrigation and minute cleanliness are the main indications. Lumbar puncture has been suggested in the early stages, and proved its value during the war if frequently repeated. The opening of the skull may be enlarged to assist drainage and relieve the intracranial tension, and not infrequently, during the course of such an operation, an abscess very near the surface is opened, with excellent results on the hernia. ('Abscess of the Brain' is discussed elsewhere; *see* p. 480.) If such an operation is done, the main object is to open up the dura mater round the neck of the fungus, the gripping of this by the dura being the main cause of the persistence of the fungus. This operation increases the risk of meningitis, but is essential for success. As a last resource, a subtemporal decompression operation should be done: A semicircular incision is made from a point immediately above and behind the external angular process, on the right side for choice, passing along the temporal ridge and ending in front of the ear. The skin and subcutaneous tissues are turned down, the temporal fascia is stripped off the muscle and also turned down, and the temporal muscle split in the direction of its fibres. The exposed bone is trephined, the disc of bone removed, the hole enlarged, and the dura mater crucially incised. This allows the temporosphenoidal lobe to bulge into the opening. The temporal muscle is then sutured, and the flaps are replaced without drainage.

GUNSHOT WOUNDS OF THE HEAD.

These may be classified into the following groups: (1) Injuries of the scalp only; (2) Injuries of the bony cranium without depression; (3) Injuries of the bony cranium with depression but without injury to the dura mater; (4) Injuries of the bony cranium with laceration of the dura and injury to the brain.

In the *examination* of these cases, there are two essentials: (1) A stereoscopic X-ray photograph; and (2) A very minute neurological examination. By means of the stereoscopic X-ray photograph the presence and localization of foreign bodies is positively decided; but equally important is the demonstration of depression of the inner table and the determination of the presence of bony fragments driven into the brain. A neurological examination is essential in deciding on the extent of the treatment to be adopted, especially with regard to the opening of an apparently uninjured dura.

Treatment.—The first point to be decided is the choice of an anæsthetic. It is generally agreed that, unless the patient is very restless, operation should be done under a local anæsthetic. An hour before the operation a hypodermic injection is given (omnopon gr. $\frac{2}{3}$, or a solution containing morphine hydrochloride gr. $\frac{1}{4}$, atropine sulphate

gr. $\frac{1}{120}$, and hyoscine hydrobromide gr. $\frac{1}{100}$). The head is shaved and cleansed, and ten minutes before the operation begins a solution of novocain 2 per cent with adrenalin is injected in a wide circle so as to surround the operation area. If an anæsthetic has to be administered, C.E. should be chosen. The scalp wound is excised, and the instruments used for this should not be used again during the operation. The cranium is freely exposed, either by extending the incision or by turning down a flap which contains the excised area. The extent of the operation is then governed by the following considerations :—

1. If the skull is uninjured, or if there is a fissured fracture without signs of intracranial complications, do not trephine.

If there are signs of increasing intracranial pressure, trephine and clear out *extradural* clot. If the dura is undamaged, do not go further.

2. If there is depression of bony fragments, elevate or remove depressed fragments. If the dura is uninjured, do not go further.

3. If the dura is injured and bony fragments or a foreign body are demonstrated in the brain, remove the bone over an area so wide that $\frac{1}{4}$ inch of healthy dura is exposed around the ruptured part. Incise the dura if necessary, but do not cut it away. Explore the brain very gently either with the finger or, as Dr. Harvey Cushing suggests, with a soft catheter, and remove only such foreign bodies or pieces of bone as can be reached without injuring the brain further. Sew up the scalp, and leave in one corner, to act as a drain, a piece of rubber cut from a glove, which must not extend to the brain.

COMA CASES.

It will fall to the lot of every house surgeon to be called upon to diagnose and treat patients who are brought to the casualty department in an unconscious condition. Some of these cases are simple and straightforward, others may be most difficult and complicated, and yet in no class of case are correct diagnosis and treatment more essential. And another point must be considered, namely, that, while in many coma cases the most accurate diagnosis and treatment are of no avail to save life, the death of a patient following a faulty diagnosis and discharge from hospital does the reputation of the institution and the medical profession an immense amount of harm. The diagnosis of the cause of coma is beset with difficulties. There is no history in many cases either of the actual onset of the present trouble or of the previous health of the patient ; no information can be gleaned from chance witnesses, who are curiously unobservant, as to the character of the 'fit' in its early stages ; and one may be easily misled by the signs of an injury which may after all be the result and not the cause of the coma, or by an alcoholic odour in the breath which is merely the result of the misdirected sympathies of the 'first-aid' enthusiast. Coma arises from so many causes, both surgical and medical, ranging from malingering to sunstroke, that every case must be approached with an absolutely open mind.

DIAGNOSIS OF COMA CASES.

	ALCOHOLISM	APOPLEXY	COMPRESSION	CONCUSSION	POST-EPILEPTIC	OPIUM POISONING	URÆMIA
Onset	Gradual	Sudden	Gradual	Sudden	Preceded by fit	Gradual	Sudden or gradual
General condition	Can be roused	Cannot be roused	Cannot be roused	Can be roused	Cannot be roused	Cannot be roused	Cannot be roused
Pupils	Dilated	Dilated, immobile	Dilated, immobile, unequal	Equal, react	Variable	Pin-point	Variable, probably contracted
Pulse	Full	Slow, full, tension +	Slow, full, heaving	Slow and weak	Becoming less rapid	Slow and compressible	High tension
Respiration	Deep, slight stertor	Slow, stertorous	Slow, deep, stertorous	Slow, shallow, irregular	Noisy or stertorous	Laboured, irregular, stertorous	
Muscles	Twitching	Hemiplegia	Organic paralysis	Functional paralysis	Relaxed	Relaxed	Recurrent convulsions
Reflexes	Present	Absent	Absent	Present	Increased	Present	
Bladder	.. .. ..	Involuntary micturition	False incontinence	Incontinence	May be incontinence	False incontinence	
Rectum	.. .. ..	Involuntary passing of fæces	Incontinence of fæces	Incontinence	May be incontinence	No evacuation	
Temperature	Subnormal	Subnormal (high in pontine)	Subnormal, rising later. May be unequal on the two sides	Subnormal	Raised	.. ..	Subnormal
Special points	Face flushed Absence of alcoholic odour in breath excludes	Face cyanosed or grey Conjugate deviation of eyes towards lesion May be albumin in urine			Cyanosis, decreasing Tongue bitten	Odour of breath Face pallid Skin sweating All secretions except sweat diminished	Look for retinitis Albumin in urine Tongue furred Breath foul

While coma may occur as the last stage in many diseases, there are certain conditions in which coma is the rule, and it is to these that attention is particularly directed.

COMMON	LESS COMMON
Alcohol	Malingering
Apoplexy	Sunstroke
Epilepsy	Exposure to cold
Concussion	Cerebral abscess
Compression (traumatic)	Poisoning, e.g., belladonna, phosphorus
Opium poisoning	Acute yellow atrophy of liver
Uræmia	Diabetes

The common causes may be grouped under the well-known 'memorizer':—

A.	Alcohol Apoplexy	*I.*	Injury	Concussion Compression
E.	Epilepsy	*O.*	Opium poisoning	
U.	Uræmia.			

The symptoms peculiar to each are arranged for the purpose of differential diagnosis in parallel columns in the table on p. 532 :—

Examination.—While a hasty examination is made to assure oneself that the patient is in no immediate danger, a history of the occurrence —whether blood or vomit was seen, etc.—should be sought from the patient's companions or helpers. A knowledge of the patient's age is often very valuable. A detailed and systematic examination is then undertaken. The depth of the coma is ascertained by making efforts to rouse the patient ; the skull is examined with special reference to the presence of wounds, contusions, or signs of bleeding or discharge from the nose, mouth, or ears. The tongue should be examined, as it may be bitten in epilepsy or present the dry, red, glazed appearance of diabetes. The odour of the breath may be of service, as it is distinctive in cases of alcoholism, uræmia, diabetic coma, and opium poisoning. Examination of the eyes may be of great value, the pin-point pupils of opium poisoning, the dilated pupils of alcoholism, and the unequal pupils of unilateral compression being characteristic. The rate and character of the pulse and respiration are noted, particular attention being paid to the degree of rigidity of the arteries and the type of respiration (I have seen one or two drunken men brought in with broken necks). The muscular tone is noted, the reflexes are tried, and other signs of organic paralysis sought for. The temperature should be taken on both sides. The amount of bladder distention must be noted, and the urine tested for albumin, blood, and sugar. In a case of probable alcoholism or narcotic poisoning, the stomach may be washed out and the contents noted. Finally, if any doubt as to the serious character of the condition exists, the patient *must* be admitted and kept under strict observation.

CHAPTER XLIX

OF DROWNING AND SOME OTHER FORMS OF SUFFOCATION

ASPHYXIA.—In all forms of asphyxia it is important to recollect, first, that insensibility comes on very soon, some time before the convulsive struggles cease, and is succeeded by a paralysis of all the voluntary muscles, including those of respiration ; and secondly, that the *heart's action may continue* for a long time after the ordinary muscular movements are abolished.

The actual cause of death is probably the hyperdistention of the right side of the heart, and it can easily be shown in animals that recovery from asphyxia is possible even after the heart has ceased to beat, if the right heart be rapidly unloaded of its blood by opening the jugular vein. In man, it is very doubtful if such a recovery has ever taken place ; but it certainly seems that prompt venesection, although it is very rarely resorted to, offers in extreme cases almost the only chance. It should be remembered, too, that the performance of artificial respiration, to be described directly, in addition to re-oxygenating the blood, also relieves the distention of the right ventricle, by facilitating the passage of the blood through the capillaries of the lungs.

It will probably save needless repetition if we here consider the steps to be taken with the object of restoring suspended animation in ordinary cases of drowning ; and taking this account as a typical case of suffocation, to leave it to the reader's common sense to fill in the details of the slight variations which are called for by the different circumstances of other forms.

Drowning.—Several causes are generally present here to produce a condition of lifelessness, in addition to the asphyxia itself. Thus, *shock* is often present, and may be a very important factor. *Exhaustion* from long-continued struggling, and the effects of *exposure to cold*, are also common, and have to be dealt with.

Still, the great agent in producing the condition is suffocation, and this must first of all be combated.

Supposing, then, that the body of an apparently drowned person has been recovered from the water, and that respiration is found to have stopped, it may well be that the breathing can be set going again by simply making sudden forcible pressure at the pit of the stomach some three or four times, at intervals of three or four seconds ; but should this not be quickly followed by respiratory movements, artificial respiration proper should at once be begun.

Artificial Respiration.—For this method to be of the least avail, all its details must be carried out regularly and thoroughly ; the object being so far to imitate the natural thoracic and abdominal movements, that air may be sucked into, and squeezed out of, the chest.

In Sylvester's Method (*Figs.* 304, 305) the arms are used as levers, acting so as to expand the chest walls by means of the muscles placed

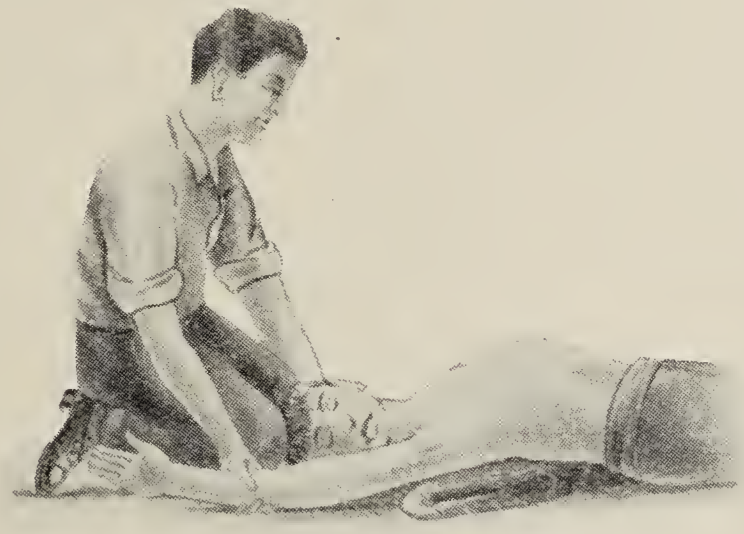

Fig. 304.—Sylvester's Method. Inspiration.

between the limbs and the trunk, the origin of the muscles acting now as insertions, and vice versa.

The patient should first be *laid on his back*, and some convenient support be placed under the shoulders, so that the chest may be thrown out, and the neck extended, with the head thrown back (*see figures*).

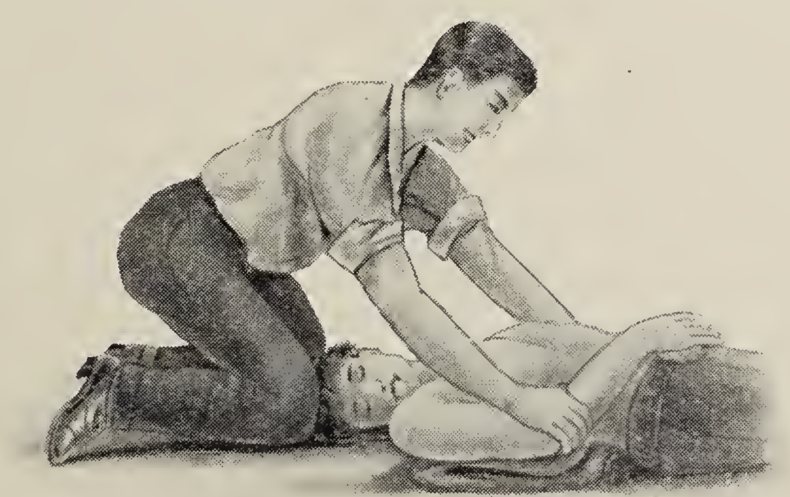

Fig. 305.—Sylvester's Method. Expiration.

If this be properly managed, there will not generally be any necessity for the tongue to be drawn out of the mouth, for the larynx will be kept open by the chin being kept well up. But it may sometimes be desirable for an assistant to *draw forward the tongue*, and if so, the best way to hold it, in the absence of proper forceps, is with the corner of a handkerchief between the finger and thumb. This is

much better than trying to fasten the organ down to the chin with an indiarubber band.

Everything which in the least confines the neck, or chest, or abdomen, must be loosened, and the mouth and nostrils cleansed from any mud, etc. Should there be any water lying in the pharynx, the patient may be *turned over on one side* to let it run out of the mouth, but no direct attempt should be made to empty the stomach.

These preparations should occupy only a few moments. As a rule, in ambulance demonstrations they are done in the most leisurely way, and if the subject were a real patient he would be dead long before artificial respiration was begun.

The surgeon then kneeling at the patient's head must take hold of the arms above the wrists, and carry them well over the head right back as far as they will go, as shown in *Fig.* 304. The chest walls will then be expanded, and generally air can be heard passing through the glottis. The arms must then be brought down against the sides, and the forearms crossed over the pit of the stomach. Leaning now with his weight upon them, the surgeon makes forcible pressure upon the abdomen, so as to press up the diaphragm and, if there is water in the air-passage, produce bubbles at the nostrils. This should elicit a distinct grunt from the patient; if it does not, it is doubtful if air has entered the chest cavity at all; the whole process is then repeated.

Rate of Artificial Respiration.—This should vary with the age of the patient, and be about the rate of normal breathing for that age, say, for an adult, 17 times a minute. Most persons, the first time they perform artificial respiration, do it very much too quickly. Slow, forcible movements are the best, but not so forcible as to break the ribs, which has been known to occur.

If recovery be going to take place, a very few minutes will usually be sufficient to restore natural breathing movements, and then care must be taken not to interfere with the short gasps with which natural respiration begins; but the patient must still be carefully watched, for the condition, like that of shock, is one very prone to relapse, and the respiration may fail again after it has been restored.

While this principal restorative process is being carried out, other *secondary aids to recovery* should be attended to. These do not differ greatly from those already described for shock. A *warm bath* should be prepared, and the dripping clothes exchanged for dry warm blankets. *Frictional warmth* is a very useful agent, and the extremities and flanks may be energetically rubbed in the direction of the venous circulation.

As soon as respiration has been fairly established, the hot bath, if procurable, may be used. The temperature must be high, say 104°, and the time of immersion short. The patient may then be put to bed between blankets, with hot-water bottles; and some stimulant, such as hot brandy and water, may be given, especially if there be still feebleness of the heart's action, or shivering.

Sylvester's method is applicable to many surgical emergencies, as,

for example, failure of respiration under anæsthesia ; for the apparently drowned the method of choice is that recommended by Schäfer.

Schäfer's Method.—Place the patient face downwards on the ground, preferably with a part of the folded coat under the lower chest. Do not lose time in attempting to remove his clothing. Begin artificial respiration as follows :—

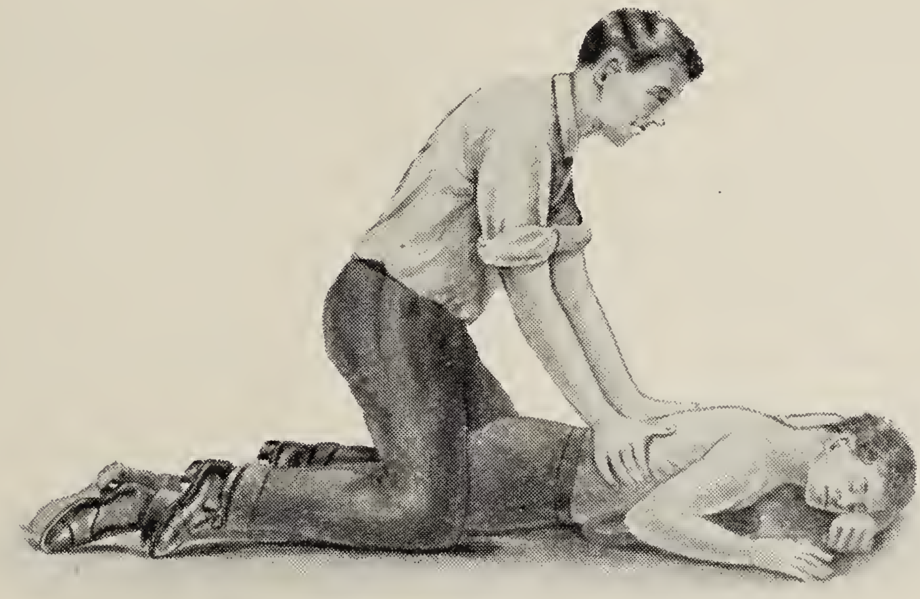

Fig. 306.—Schäfer's Method. Inspiration.

1. Place yourself athwart or on one side of the patient's body in a kneeling posture and facing his head.

2. Place your hands flat over the lower part of the back (on the lowest ribs), one on each side, and gradually throw the weight of your body forward on to them, so as to produce firm pressure—which must not be violent—upon the patient's chest.

Fig. 307.—Schäfer's Method. Expiration.

3. Raise your body slowly, so as to remove the pressure, but leaving your hands in position.

4. Repeat this forward and backward movement every four or five seconds (*Figs.* 306, 307).

This course must be pursued for at least half an hour, or until the natural respirations are resumed. When breathing has been established, the patient may be turned on his back and active means employed to

promote the circulation by friction of the limbs in a direction towards the heart, the application of hot flannels, hot bottles, etc. As soon as the patient can swallow, small quantities of wine, warm brandy and water, beef-tea, or coffee may be administered. He should then be put to bed and encouraged to sleep.

Other Forms of Suffocation.—In *suffocation by the fumes of charcoal or coke*, by the *carbonic acid in brewing vats*, by the *choke damp* of mining accidents, or by *hanging*, we have examples of suffocation, in all of which the great agent for resuscitation must be artificial respiration. As a rule the conditions are more simple than in drowning, as shock, or exhaustion, or cold, the effects of which in drowning have to be overcome, is not generally present, but the main principles of the treatment remain the same. The inhalation of oxygen gas may prove of value in these cases.

We have mentioned already, when considering the treatment of extreme shock and syncope, most of the other measures which are accessory to artificial respiration in cases of suspended animation from whatever cause arising; but although *faradization* has been alluded to in connection with the recovery from some poisons, such as opium, chloral, or prussic acid, and also on other occasions, the details of the administration of the electric current have not yet been given. The following are in brief the directions which should be followed.

The faradic current is usually employed, but the interrupted galvanic current might answer the purpose.

Graduate the current to a strength sufficient to produce vigorous contractions of the muscles of the ball of the thumb. Then press the electrodes firmly over the phrenic nerves, between the sternomastoid and scalene muscles; or, put one electrode over one phrenic nerve and the other in the seventh intercostal space.

Interrupt the current about three times a minute, while the assistant presses firmly on the abdomen, pausing occasionally to observe the effect.

If no inspiratory movements appear after a number of interruptions, increase the strength of the current.

The electrodes must be large, and well moistened.

The resuscitation of stillborn infants, though carried out on the same general principles as those of the other cases of suffocation, does not come within the list of emergencies to which we have limited ourselves.

Foreign Bodies in the Œsophagus.—Two forms of suffocation must be specially mentioned, those, namely, which are due to the lodgement of a foreign body in the commencement of the œsophagus, or somewhere in the larynx or trachea.

Commonly enough a piece of hard meat is 'bolted,' and is arrested at the narrowest part of the œsophagus, namely, at the top, just behind the cricoid cartilage. Great distress, and even dangerous symptoms of suffocation, may thus be caused, which if not relieved

immediately may result in death from asphyxia. Sometimes it is possible to reach the lump with the finger, in which case naturally the best thing to do is to hook it up. Failing this, the next best, and

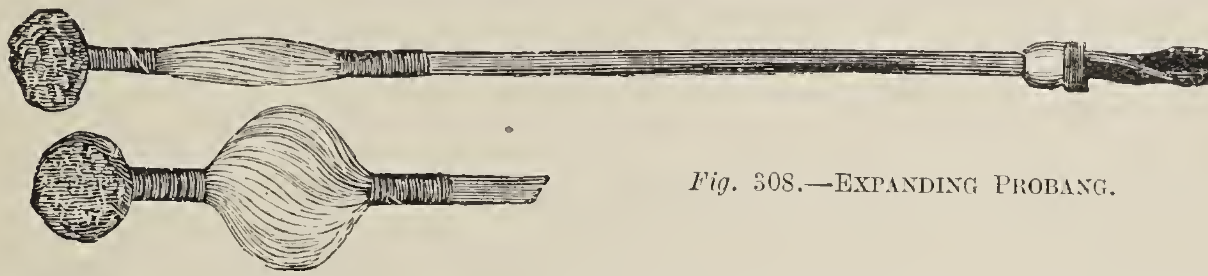

Fig. 308.—Expanding Probang.

the more common plan, is to push it gently onwards. Frequently, too, the lump may be moulded into a more convenient shape by pressure from the outside of the throat. So soon as the mass passes the commencement of the œsophagus, it may be trusted to go down of itself.

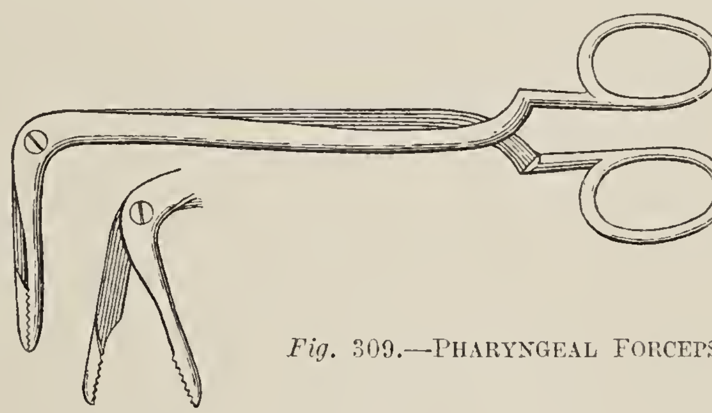

Fig. 309.—Pharyngeal Forceps.

A good deal of distress is frequently caused by the sticking in the throat of a *fish-bone*, or some other small pointed or jagged foreign body. If the body be quite soft and flexible, probably the best way to get rid of it is to swallow a good mouthful of bread and to drink some water; but if there be any reason to suspect that injury to the lining mucous membrane may thus arise, it must not wilfully be pushed on, but an effort must be made to extract it.

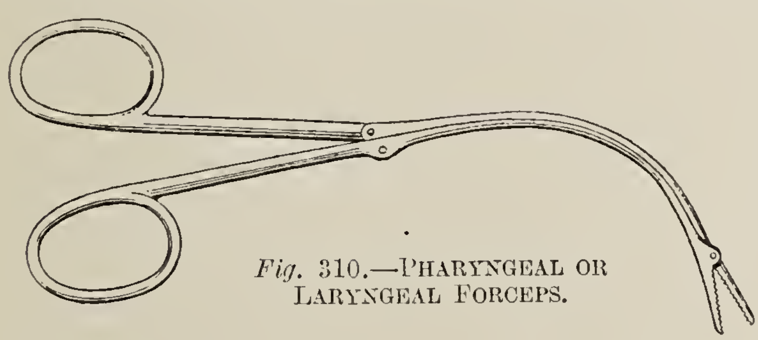

Fig. 310.—Pharyngeal or Laryngeal Forceps.

Assiduous search for foreign bodies must be made owing to the danger of their sloughing through the œsophageal wall into the mediastinum and so initiating a fatal mediastinitis, or into the aorta and causing a fatal hæmorrhage.

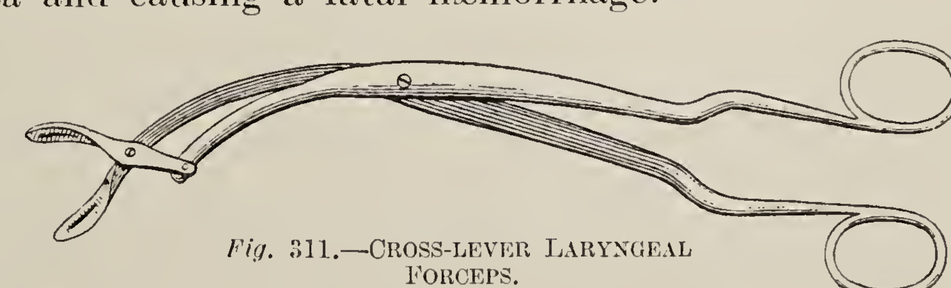

Fig. 311.—Cross-lever Laryngeal Forceps.

In modern surgery the use of the bronchoscope and the œsophagoscope in conjunction with X rays enables the operator to view the air-passages and the œsophagus directly, and to extract a foreign body with precision and safety (*see also* p. 463 et seq.). Only in the absence of these instruments should the following more uncertain methods be employed.

For small bodies, such as a *pin*, *small sharp splinters of bone*, and the like, a probang may be used, an instrument with bristles arranged so that they occupy little room as it is passed down, but which on its withdrawal can be expanded into a form something like a chimney-sweep's brush, in the meshes of which the object may be entangled (*Fig.* 308).

But if this expedient should fail, or if the foreign body should be larger (and we may adduce as the most common examples a set of false teeth, and coins), it would not be safe to use a probang, and patient attempts must be made to extract it by means of forceps of special construction, of which some examples are here given (*Figs.* 309, 310, 311), or by means of a coin-catcher or snare. If the body can be touched at all, or its locality made out with the fingers, extraction will generally be easy enough; but if not, it may be extremely hard to lay hold of, and the greatest patience and skill will be required.

If all these attempts should fail, the question of operative measures will have to be raised, but as we do not here propose to discuss these, we have only further to express the opinion that *it is bad surgery to produce vomiting* (as has been recommended) under any circumstances, and also that the dresser or house surgeon should never on his own responsibility attempt to push onwards into the stomach a foreign body which he has failed to extract, unless that body be of such a shape and nature—as the lump of meat or soft fish-bone mentioned before—that its presence there will not be hurtful.

The exact position of a piece of metal, such as a coin, needle, or pin, in the œsophagus must be located by means of the Röntgen rays, which will assist greatly in the use of a coin-catcher or in an operation.

When any foreign substance (other than a poison) has once passed into the stomach, no attempt should be made to recover it by means of vomiting, nor should purgatives be given. The diet should be of a kind which will give the substance the best chance of being enveloped in pultaceous material, and the stools of course should be carefully sieved for it. Under such circumstances, bodies such as coins, marbles, etc., may be confidently expected to be passed in the course of a few days, and even such irregular bodies as plates for several false teeth, with numerous pointed hooks, have been harmlessly expelled.

It is a somewhat curious fact that very irregular and jagged bodies often pass through the whole length of the alimentary tract, without causing any pain or trouble, until they are within an inch or two of the anus, when they are arrested, and may give rise to ulceration and hæmorrhage, ischiorectal suppuration, or other serious mischief. Their position in the bowel should be frequently checked by X rays, for in the event of a foreign body becoming fixed in one place for several days, exploratory operation would be necessary before perforation into the peritoneal cavity could take place.

SECTION X

OF THE ADMINISTRATION OF ANÆSTHETICS

CHAPTER L

ANÆSTHETICS

By JOSEPH BLOMFIELD, M.D.
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A GENERAL knowledge is presupposed on the part of the reader of the physiological and chemical properties of those bodies which are in common use for the production of anæsthesia ; no space is therefore given here to the purely scientific or historical side of anæsthetics, and I proceed at once to the practical questions of their selection and administration.

CHOICE OF THE ANÆSTHETIC.

There are certain general considerations to be taken into account in all cases : (1) The safety of the patient ; (2) The convenience of the surgeon in the performance of his operation ; and (3) The comfort of the patient and his freedom from after-effects. From the point of view of both safety and comfort, **Nitrous Oxide,** with or without oxygen, ranks first among anæsthetics, and will therefore always be chosen when possible. The continuous administration of nitrous oxide, however, involves an amount of labour and the co-operative use of local analgesics which render its use inconvenient for any but short operations. Moreover, relaxation of muscles cannot be relied upon under its influence ; therefore, when this condition is essential to success, nitrous oxide is not to be chosen. Neither should it be chosen for such operations as the breaking down of joint adhesions, for instance, in which severe pain is felt immediately on return of consciousness : some anæsthetic is to be preferred with which this return is more gradual, and, generally speaking, **Gas** and **Ether,** used for a few minutes, gives an ideal result, perfect relaxation of muscles being achieved and the patient only gradually awakened to a deadened sense of pain. Broadly speaking, any operation that is to last not more than five to ten minutes, that does not require muscular relaxation, and that does not interfere with especially sensitive parts of the body, may be best performed under nitrous oxide. At the same time it must be stated that in expert hands and with the most recent technique and apparatus there is practically no limitation to the use of nitrous oxide with oxygen, even for cases in the face and throat

area. In most instances, however, of long operations requiring muscular relaxation, the 'gas and oxygen' has to be supplemented by more or less ether or chloroform, through which the gases are driven on their way to the patient. When used over several minutes, the gas is of course inhaled with air or oxygen as described later. Opening of abscesses, removal of teeth, of sebaceous cysts and small innocent tumours, of gauze plugs from the abdominal cavity, of tonsils, etc., are examples of the kind of case in which nitrous oxide is available with the most gratifying results for those who have become proficient in its use. In a case of empyema in which the subject was extremely ill and weak, I have found nitrous oxide and oxygen serve for anæsthesia during removal of ribs, with a freedom from dangerous symptoms that I believe no other anæsthetic could have given.

The next safest anæsthetic to nitrous oxide is **Ether,** and this should be our routine agent for longer cases. In many conditions where, from the condition of the patient or the site of the operation, ether is inadvisable, **Chloroform** is required. In other cases some **Mixture of Ether and Chloroform** may be the most suitable agent, and in yet others **Ethyl Chloride** is best chosen. In rare instances rectal administration of **Avertin** is the best method at our disposal, and in others all general anæsthetics should be abandoned in favour of spinal or of local injections. The administration of these different anæsthetics will shortly be described in the order named.

In choosing the anæsthetic most suitable for a particular case, we are further guided by: (1) The physical and mental condition of the patient; (2) The nature and site of the operation to be performed.

Too much stress cannot be laid upon the importance of noticing carefully both the patient's nature, physical and temperamental, and any variation from the normal due to the disorder for which operation is required. For instance, the muscular, red-faced, thick-necked sailor is best anæsthetized by treatment very different from that appropriate to the pale, flabby, overworked maidservant, though both may be at the time in ordinary good health and about to undergo the same operation. Nor will that treatment be the same in either case if the sailor has acute laryngitis from smoke and drink, or the maidservant an empyema. The day has gone by when an anæsthetist should be content to say, 'I give chloroform,' or 'I give ether.' To get the best results he must vary the choice of his anæsthetic in accordance with the requirements of each case. Nevertheless, for those who, not being professed anæsthetists, cannot acquire a large experience with all kinds of anæsthetics, it is best to use the same agent as often as possible, and to become thereby proficient in the use of that one rather than only partially competent to use all. For such routine use in all cases I recommend the C.E. mixture (chloroform 2 parts, ether 3 parts), with which the vast majority of cases can be well managed. Ether, though safer, has not so wide an applicability, for

it is not suited to any persons suffering from acute affections of the respiratory tract, diphtheria, bronchitis, etc., nor is it a convenient agent with which to manage long operations upon the face or within the mouth or nose.

Briefly, then, rules for choice of anæsthetics may be stated as follows :—

1. If opportunity does not permit the acquisition of wide experience with all anæsthetics, use *C.E. mixture* as a routine.

2. Supposing this disability not to exist, use *nitrous oxide* with air or oxygen for operations lasting up to ten minutes where muscular relaxation is not essential and which are not followed by much pain. Use nitrous oxide and oxygen also for long operations or comparatively insensitive parts—e.g., long bone operations—and use it wherever possible for all patients whose general condition is poor, particularly if this is due to any form of sepsis. Never use nitrous oxide in cases where there is pressure on larynx or trachea, e.g., angina Ludovici, mediastinal tumour.

3. For longer operations in healthy subjects, use *ether*. In the very young and in the old, and in the case of long operations, especially upon the abdomen, this will be given by the open method. In other cases use Clover's inhaler, preceding the ether for choice by nitrous oxide.

4. In cases of acute affections of any part of the respiratory tract, use *chloroform* ; this applies also to cases of active phthisis. In these cases it is often of great advantage to administer oxygen together with the chloroform.

5. Except on account of rule 4 never induce anæsthesia by chloroform. In cases such as long operations upon the tongue, larynx, nose, pharynx, etc., where chloroform has often to be used during operation, induce anæsthesia with gas and ether or C.E. mixture according to the case.

6. For operations upon the neck, head, and face, choose *C.E. mixture*. Gas and ether cause extra vascularity and hæmorrhage. This applies also to cases of tonsils and adenoids. For operations upon the brain, use open *ether* or ether by intratracheal insufflation. For exophthalmic goitre, use open ether.

7. For operations within the thorax, use *chloroform* unless the patient's condition is extremely bad ; in that case use ether by the open method. Some of these cases are best managed with intratracheal ether, or, in the case of extensive thoracoplasties, intratracheal gas and oxygen.

8. For abdominal operations (*vide* rule 3) when the patient is particularly muscular, or much accustomed to alcohol or tobacco, and the operation requires very complete relaxation, as, e.g., prostatectomy, give $\frac{1}{3}$ gr. *omnopon* hypodermically half an hour before operation, in combination with *atropine*, $\frac{1}{100}$ gr.

9. For rectal operations and operations upon the genito-urinary tract, use *ether*, unless contra-indicated by the patient's general condition.

10. Some special cases may be mentioned where the best practice differs perhaps from the above rules. *Enucleation of the eye* is generally best performed with the patient under ether. The extra vascularity does not matter in the same way that it does in operations on the surface of an eye. If ether be given continuously for about ten minutes, a deep anæsthesia being caused, the apparatus may then be removed and no further anæsthetic required during the operation. *Circumcision* in infants should always be performed under ether. In every operation upon the *nose* and *tongue*, it is best first to get the patient deeply under the influence of ether, then give chloroform, allowing the congestion to pass off, and continue with chloroform from a a Junker's tube throughout. This practice enables chloroform to be given safely to persons in the sitting posture during long periods. The same rule applies to removal of the *Gasserian ganglion* in the sitting position. In feeble subjects, for tongue operations, use ether throughout, continuing by means of Crile's apparatus ; or, if expert in its use, employ intratracheal insufflation of ether.

EXAMINATION AND PREPARATION OF THE PATIENT.

Before giving any anæsthetic, it is well to examine roughly the state of: (1) The *circulation*, by carefully feeling the pulse ; (2) The *respiration*, by laying the hand lightly on the chest while the patient breathes deeply ; (3) The *inside of the mouth*, by inspection. False teeth, etc., will be removed, and if inspection shows evidence of nasal insufficiency or of very accurately meeting teeth, a small prop will be put between the teeth before administration is begun. The condition of the urine should also be known. A Mason's gag (*Fig.* 312), and a wooden wedge (*Fig.* 313) for opening the mouth if necessary, and a tongue forceps (*Fig.* 314) should be at hand, as well as a small sponge for swabbing the pharynx in case of need. On the rare occasions when it is necessary to hold the tongue forward for a length of time, this is best done by a stout piece of silk passed through it in the middle line about half an inch from the tip. This causes less damage than any form of tongue forceps, though a pair of these may be necessary for drawing the tongue out. The tongue clip designed by Bellamy Gardner is also efficient and does not damage the tongue.

Fig. 312.
Mason's Gag.

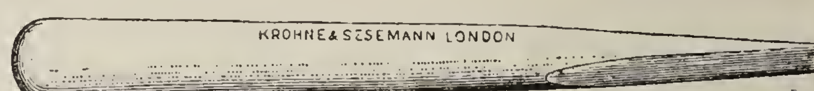

Fig. 313.—Wooden Wedge.

Whenever possible, a purge should be given thirty-six hours before operation. Ordinary diet, light and in small quantity, should be

taken during the two days preceding operation, and no food for the six hours immediately preceding it. A cup of tea or thin soup may, however, often be taken with benefit three hours before. In the case of infants, operation should take place at what would be a feeding-time, no previous starvation being thus involved. Very feeble or aged persons must of course not be subjected to the long deprivation of food; thin broth, and in some cases neat brandy even, shortly before the administration, are good in such instances. Before operations on children, it is good practice to give extra amounts of sugar during the preceding twenty-four hours. This is done by systematic administration of glucose, or by letting the child have an amount of barley sugar to be sucked during the day.

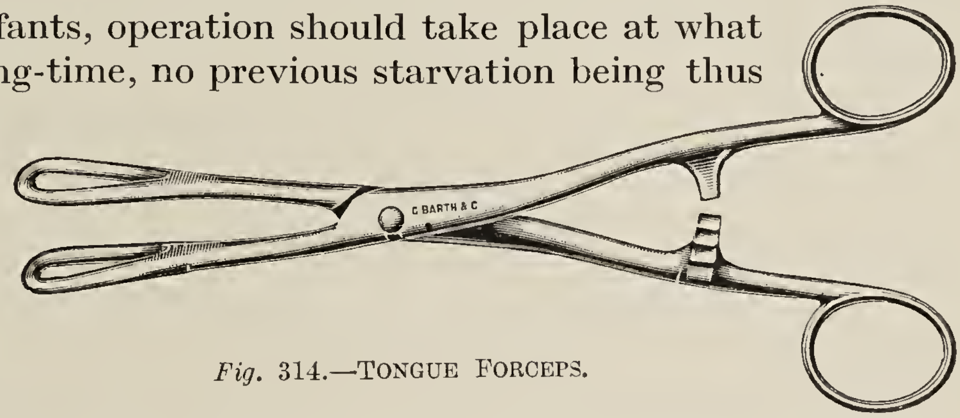

Fig. 314.—Tongue Forceps.

ADMINISTRATION OF THE ANÆSTHETIC.

For the Administration of Nitrous Oxide two side-valve cylinders (*Fig.* 315) are necessary, each yielding 50 gallons of the gas, with stand, double union, and foot-key. For hospital work larger cylinders are commonly used. The cylinders are joined by an indiarubber tube to a bag capable of holding 2 gallons of the gas, and this is connected with the face-piece by a metal-valved stopcock. The cylinders are not to be used alternately, but the foot-key is kept upon one, which is employed till it is exhausted. The other is then used and the empty one replaced by a full cylinder. Before using, test the apparatus by letting a little gas flow into the bag and squeezing it out through the expiratory valve. Place the cylinder in such a position that the foot-piece is easily used

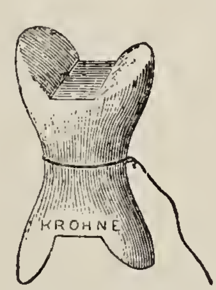

Fig. 316.—A Small Wooden Mouth-prop.

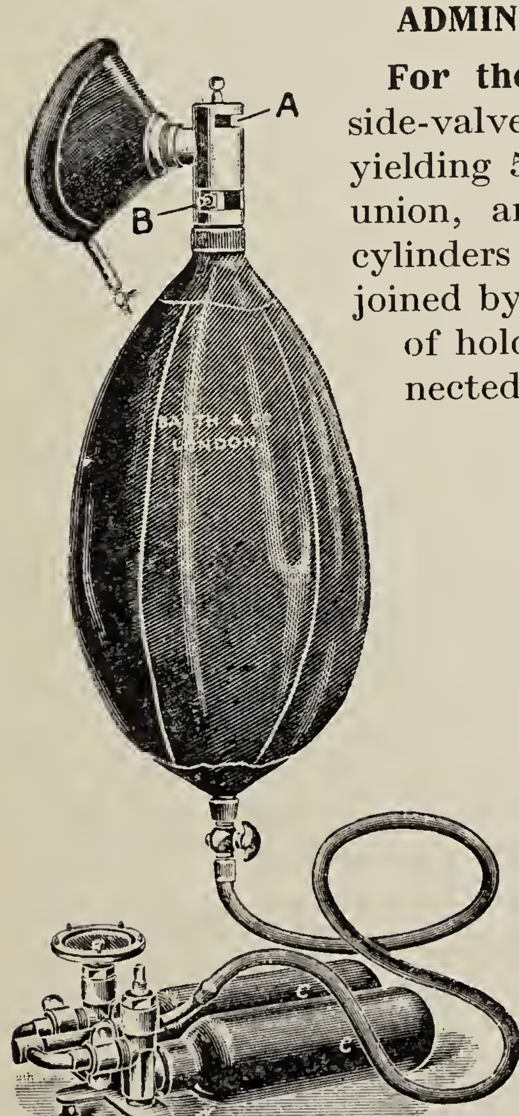

Fig. 315.—Nitrous Oxide Cylinders, with stand, bag, and mouthpiece.

while the face-piece is being held to the patient's face. Fill the bag about two-thirds full, with the valve B off and A open. Place a small prop (*Fig.* 316) between the patient's teeth. With the patient lying or sitting, as required, apply the face-piece gently but accurately. If the patient is in a dental chair, be sure that the head is not over-extended; there is a tendency to throw it back. If there is a moustache or beard, it should be moistened with water where the face-piece lies upon the hair. Hold the face-piece in position with the left hand, keeping the little finger below the patient's chin. Ask him to breathe in and out of the mouth, and turn on B with your right hand. Turn the foot-key so that gas streams gently into the bag. Nitrous oxide is now being breathed from the bag, and expirations are passing out through A. During the first few breaths there is often rapid twitching of the eyelids. After about twenty breaths the respiration is quicker and deeper than natural, the face dusky, and the pupils dilated. After about thirty breaths the jerky, guttural, stertor-like inspiration arises which is characteristic of nitrous-oxide anæsthesia, and the conjunctival reflex is now generally gone, the corneal persisting. The face-piece is then to be removed. Sometimes clonic twitching of fingers or limbs—'jactitation movements'—arise before the stertor, and are equally an indication to stop the administration. If the longest anæsthesia possible is aimed at, instead of removing the face-piece when these symptoms arise, breaths of air are admitted through A till the stertor or jactitations have subsided, and then further gas is admitted. In this way, by giving four or five breaths of nitrous oxide, then one or two of air, then nitrous oxide again, and so on, the patient is able to be charged up with the maximum amount of the gas. When the operation is not one upon the face or inside the mouth, this process may go on and anæsthesia be maintained conveniently for ten minutes or so. It is used with dental cases when several teeth are to be extracted; when only one or two easy extractions are to be effected it is only necessary to give the nitrous oxide uninterruptedly till the advent of twitchings or of stertor, and then stop the administration. Very occasionally signs of faintness will arise before these stopping symptoms. The administration must then of course terminate without waiting for stertor or jactitation. In many cases considerable muscular excitement occurs. The treatment is steady perseverance with the gas, admitting a breath of air if the colour is markedly dusky. The common mistake with nitrous oxide is not to give enough. To prolong anæsthesia without admitting air and to a less extent than by the method described, some anæsthetists close the expiration valve when stertor arises, allowing re-breathing for a few breaths before removing the face-piece. When this is done the bag must be properly cleansed before the next administration. When no re-breathing is permitted, it is enough to cleanse the face-piece. In hospital dental practice it is essential therefore to have

several face-pieces in use in rotation, one remaining in perchloride 1–2000 while the other is employed. The use of *nitrous oxide and oxygen* together requires special apparatus, and is not recommended except for the expert. It will therefore not be described here. The same remark applies to the nasal administration of nitrous oxide for prolonged anæsthesia during dental operations.

Ether.—Next to nitrous oxide in point of safety comes ether. This may be administered by closed, open, or semi-open methods. In addition there are for special cases : (1) Intravenous infusion of ether in normal saline (5 to 7 per cent) ; (2) Intratracheal insufflation of warmed ether vapour ; (3) Rectal administration of ether with olive oil. The semi-open methods are rarely of special advantage ; the open are most suitable for continuing an administration or for weaker subjects ; so we first describe a closed method which is practically suitable for any average patient between the ages of five and seventy. The apparatus recommended is Hewitt's wide-bore modification of Clover's inhaler (*Fig.* 317), and the administration is carried out as follows : The patient's head being to one side and the face-piece screwed on to the ether chamber in such a way that the filler is in a convenient position for pouring in, gently apply the face-piece so that the narrow end rests on the forehead just above the bridge of the nose. The inhaler is previously warmed by loading it with an ounce of hot water which is then poured out again. Grasp the face-piece with the left hand, the little finger resting below the chin and keeping it gently raised. Instruct the patient to breathe quietly in and out of the mouth, and raise the apparatus with the right hand so that the lower end of the face-piece is off the face during the first three inspirations. The expirations are caught in the bag as the lower end of the face-piece is re-applied. Now, with the patient breathing into and from the bag, take out the stopper and pour in $1\frac{1}{2}$ oz. of ether. The indicator, which is figured from '0' onwards, has hitherto stood at '0.' It is now pushed forward with each inspiration in such a way that a minute is taken to reach '$\frac{1}{4}$.' After this point the indicator is pushed on more rapidly if there is no coughing or holding of the breath, either of which symptoms indicates too rapid increase in the strength of the ether vapour inhaled. When the index reaches '$\frac{1}{2}$,' give one breath of air. By the time this point

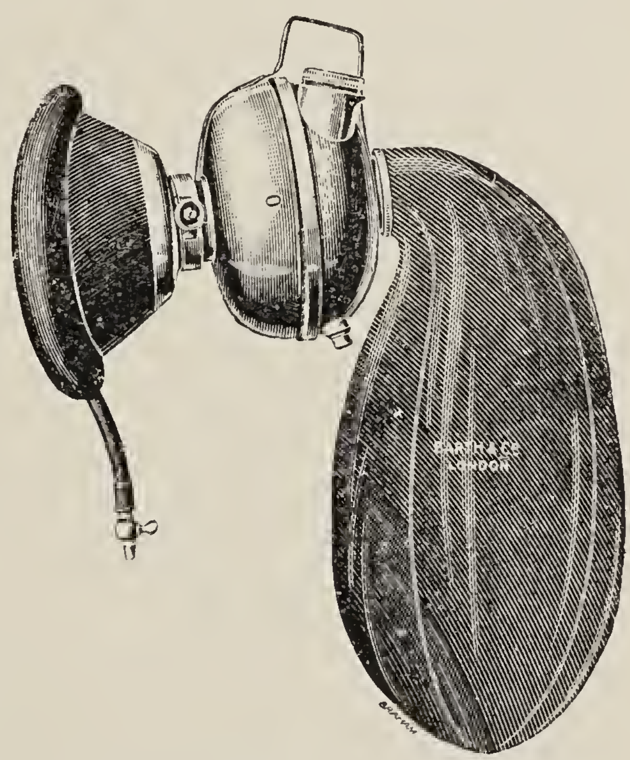

Fig. 317.—Wide-bore Clover's Inhaler.

is reached consciousness should be fully abolished, as shown by no response being made when the patient is loudly told to raise an arm. At this time there will be some duskiness of the face, and both pulse and breathing are quickened. There should be also (1) Loss of conjunctival reflex, (2) Stertorous inspirations, (3) Flaccidity of muscles, the arm, if raised, dropping limply to the side when released.

Should the patient be a woman, child, or slightly built man, it is not necessary to increase the strength of the ether vapour further, but the index should be kept at '½' till the skin incision is made. In the case of strong subjects, it is better to push on to 'F' before this is done, replacing the index to '½' if no reflex is evoked by the cut. When full anæsthesia has been reached, as shown by the symptoms just enumerated and reduction of the corneal reflex to a faint response, air must be admitted in a sufficient quantity to keep the colour entirely free from any blueness. Either the bag must be left off, admitting air continuously through the top of the instrument, or else, if the bag is used, the face-piece must be lifted frequently. One breath of air to four breaths from the apparatus generally suffices, but the anæsthetist must be guided by the colour, cyanosis being entirely avoided. Care must be taken to keep the lower jaw well forward, so that there is no obstruction due to the base of the tongue having been drawn back with inspiration. It is often necessary to open the mouth slightly and ensure the patient's breathing freely through the mouth throughout. The insertion horizontally of the small prop (*Fig.* 316) will generally secure this. Very rarely the tongue requires to be held forward, the frequency with which this occurs being inversely as the experience of the anæsthetist. In the course of an induction as just described, there will occasionally, in alcoholic or very muscular subjects, be a period of muscular excitement and spasm. This is to be met by keeping the face-piece steadily applied and increasing the admission of ether, which will soon replace the spasm by relaxation.

When ether is preceded by nitrous oxide, the principle of administration is the same as with the method just described. The nitrous-oxide apparatus (*Fig.* 315) is used, the gas-bag fitting on the top of the Clover instead of on the face-piece. The administration is begun by admitting nitrous oxide alone for the first four breaths ; ether is then inserted into the Clover, and the index being slowly advanced, the patient breathes nitrous oxide, but with an increasing amount of ether vapour. When '½' is reached, the stopcock admitting N_2O is turned off, the large bag replaced by the small one, and the administration continued as with ether only. This method is pleasanter to the patient, and unconsciousness comes more quickly. It involves much apparatus, however, and needs considerable practice in order to get the best results. It is, generally speaking, therefore best left for those only who are constantly administering anæsthetics. *Ormsby's*

inhaler is another useful instrument for giving ether by the closed method (*Fig.* 318). It is much more simple than a 'Clover,' but it is not so well adapted for comfortably inducing anæsthesia, since the gradual admission of the vapour is not regulated. This is achieved simply by holding the inhaler at some distance from the face and gradually advancing it till it rests there. Half an ounce of ether is first poured upon the sponge, and this must be replaced from time to time, for which purpose, as well as for air admission, the inhaler is removed from the face.

For giving ether by the *open method*, a mask is required of the Schimmelbusch kind (*Fig.* 319), on which are stretched eight layers of surgical gauze or three or four of domette. A coil of gauze is laid upon the patient's face, and on this the mask rests. He is encouraged to breathe in and out through the mouth, and then drops of ether are allowed to fall upon the mask opposite to the mouth in gradually increasing quantities. Eventually the mask is kept saturated with ether. Induction takes considerably longer than by

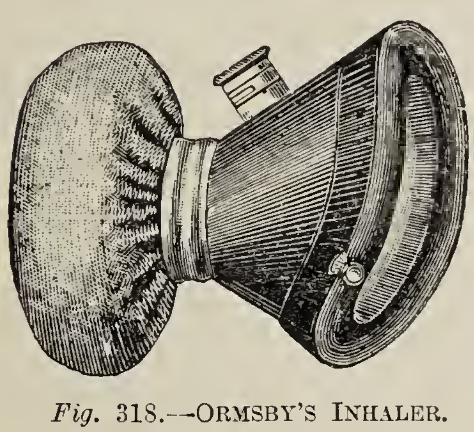

Fig. 318.—ORMSBY'S INHALER.

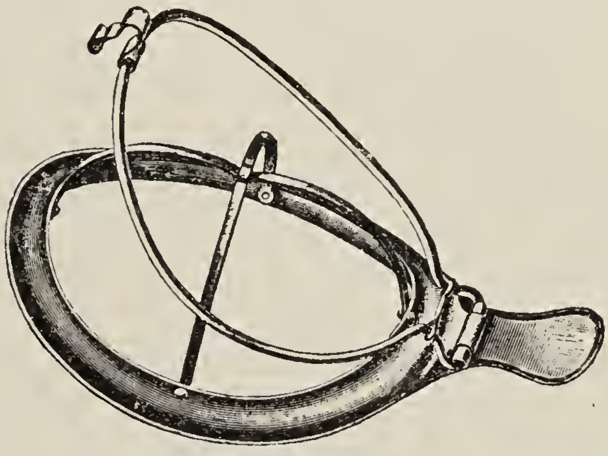

Fig. 319.—SCHIMMELBUSCH'S MASK.

the closed method, but is accompanied by less spasm and less secretion of mucus. For a strong subject, large quantities of ether are necessary, and the air of the operating-room becomes considerably laden with the vapour. To be certain of success with 'open ether' the administration should be preceded by a hypodermic injection of morphia gr. $\frac{1}{4}$, atropine gr. $\frac{1}{100}$, given three-quarters of an hour before the time of operation. Some anæsthetists prefer to add scopolamine (gr. $\frac{1}{100}$) to these drugs.

Ether is often given *immediately preceded by ethyl chloride.* The combination is effective and acts with extreme rapidity, but is not without risk, and is best reserved for patients of a very resistant kind, such as muscular alcoholics. A small prop is always to be inserted between the teeth before beginning, for much spasm of the jaws may arise. A Clover's apparatus is used, the small bag being fitted with a tap through which the ethyl chloride is to be inserted. Charge the inhaler with ether, squirt 4 c.c. of ethyl chloride into the bag, and put the inhaler on the face in such a way that the bag hangs down. Raise the bag during the first three breaths, so

that it comes into line with the inhaler. Turn ether on to '$\frac{1}{4}$.' If the conjunctival reflex is gone, push on to '$\frac{1}{2}$.' By this time stertor will be present. Remove the bag, thus admitting air to the patient. Press what vapour is in the bag out of it, and replace it so as to catch an expiration. Continue as with ether alone.

Intratracheal insufflation of ether is a method of administering the vapour which is of great value in the case of operations upon the face, neck, and upper air-passages, and most of all in operations within the thorax, and in operations on the cerebellum when the patient's head has to be severely flexed. It combines the functions of ether administration and performance of artificial respiration, the vapour being driven into the lungs irrespective of respiratory movements, and the return current at the side of the tracheal tube rendering the entry of blood into the air-passages impossible. An elaborate apparatus with electric or bellows motor power is necessary, and the passage of the tracheal tube requires much practice. Consequently the method, though of great value in selected cases, is not one to be described in detail here.

Rectal administration of ether is also of convenience for cases of operation upon the upper air-passages and for goitre. A perfectly normal condition of anus and rectum is a *sine qua non.* The lower bowel must be thoroughly washed out on the evening before operation, and again three hours before. Half an hour before operation a mixture of olive oil and ether, containing 75 per cent of the latter and not exceeding 8 oz. in amount, is slowly injected through a rectal tube passed about four inches up the bowel, the patient lying in bed upon the left side. The tube is clamped and left in position so that the ether-oil can be removed if narcosis becomes undesirably deep, as shown by stertor or absent corneal reflex. A preliminary injection of *omnopon* or *atropine* is generally desirable.

The administration of *warmed ether vapour* is of value in cases of shock or of much feebleness. The method allows of continuous supply of a perfectly constant strength of vapour, and thus a light level of narcosis can be maintained without fear of reflex movements. The apparatus (Shipway's) is simple and not cumbrous, and is easily worked by a hand pump as with the Junker inhaler ; it has bottles for ether and for chloroform, so that a warm vapour of either drug or of varying mixtures of the two can be supplied at will, the vapour being warmed by its passage through a tube that dips through a 'Thermos' kept at about 110° by hot water.

Chloroform.—This anæsthetic has always to be administered with a large admixture of air. About 2 per cent of chloroform vapour to 98 per cent of air is recognized as the safe strength, and the problem for the administrator is to supply his patient uniformly with a weak and constant atmosphere. The regulating inhalers hitherto introduced are not sufficiently convenient or widely applicable to be described in a purely practical book of this kind, and we

pass on to methods by which chloroform can be safely administered with the simplest apparatus. By use of a *drop-bottle and an open mask* (Skinner's or Schimmelbusch's) (*Figs.* 319, 320), the required strength of chloroform vapour can be supplied. The mask should have not more than one thickness of flannel, lint, or domette. The exact percentage given in this way is not known, but we have experimental evidence that if by *never letting the mask touch the face* a layer of air is kept between the two, it is difficult to exceed greatly the safe 2 per cent, even if a large portion of the mask is kept wet with chloroform The drop-bottle should hold at least two ounces, and be supplied with a Thomas's or Hewitt's stopper. Either of these permits pouring on the liquid in single drops or a continuous stream, according as the stopper is arranged. Start with the mask at least two inches off the face, and with the chloroform at first drop by drop. It is best for the first few breaths to give no chloroform at all, and the patient is encouraged by noticing nothing; then with the very weak vapour supplied by a few drops he is not put off his breathing, so to speak, but will inhale freely until, with constant and increasing amounts being put on the mask, and the lowering of this till it is within half an inch of the face, he is lulled into unconsciousness. The process till complete anæsthesia is reached should take at least six minutes in a healthy adult. Safety lies in starting slowly enough, and in the management of the stage of spasm should this occur. With muscular and alcoholic individuals, it is not rare for considerable rigidity of muscles to arise, with holding of the breath, throwing out of legs and arms, and spasm of jaws. This happens when all control of the higher faculties is gone, and though the patient might hear uttered directions, he could not carry them out. This period of chloroform inhalation is associated with danger owing to the strain thrown on the right side of the heart by the embarrassed or abolished respiration. Where such a stage is very pronounced, the safest plan is to substitute ether for chloroform till the spasm is over. In strong subjects, have at hand, before beginning, an Ormsby's inhaler and two ounces of ether. When the spasm is fully developed, replace the chloroform mask by the Ormsby loaded with an ounce of ether. Full anæsthesia with relaxation of muscles will quickly be established. In weaker subjects it is enough to pour ether on the open mask instead of chloroform, until the spasmodic stage is over. Throughout the administration of chloroform,

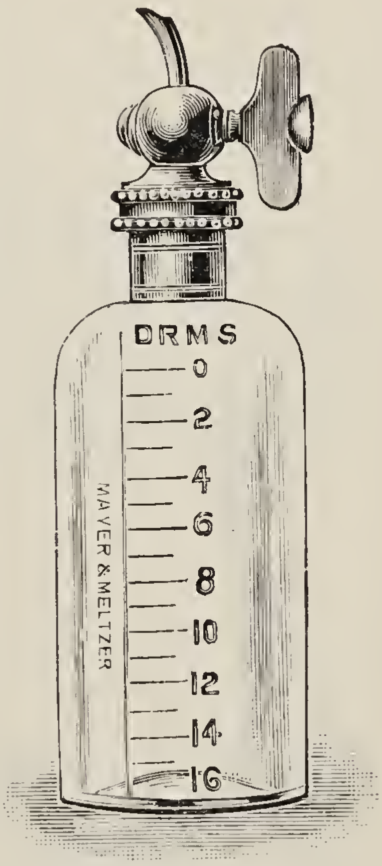

Fig. 320.—DROP-BOTTLE.

when anæsthesia is once fully obtained, a very much smaller dosage is employed than for induction. It is generally quite enough if a quarter of the mask, which should be made with domette, is kept moist. The drug must be added by drops, and it must be the anæsthetist's aim, by frequently adding very small amounts, to supply a uniformly weak vapour. Roughly speaking, a drachm should last five minutes during an operation upon an adult. The chief guide to the condition of the patient is his respiration, which must be continuously and closely watched. Nothing but a perfectly regular respiration, at least as vigorous as that of normal sleep, must be regarded as satisfactory. The corneal reflex and the pupil are valuable indications. The former should, as a general rule, be kept just perceptible, and the latter in a moderately contracted state. The condition of the pupil is rarely, however, a safe guide till operation has been in progress for some minutes. Shallow breathing, pallor,

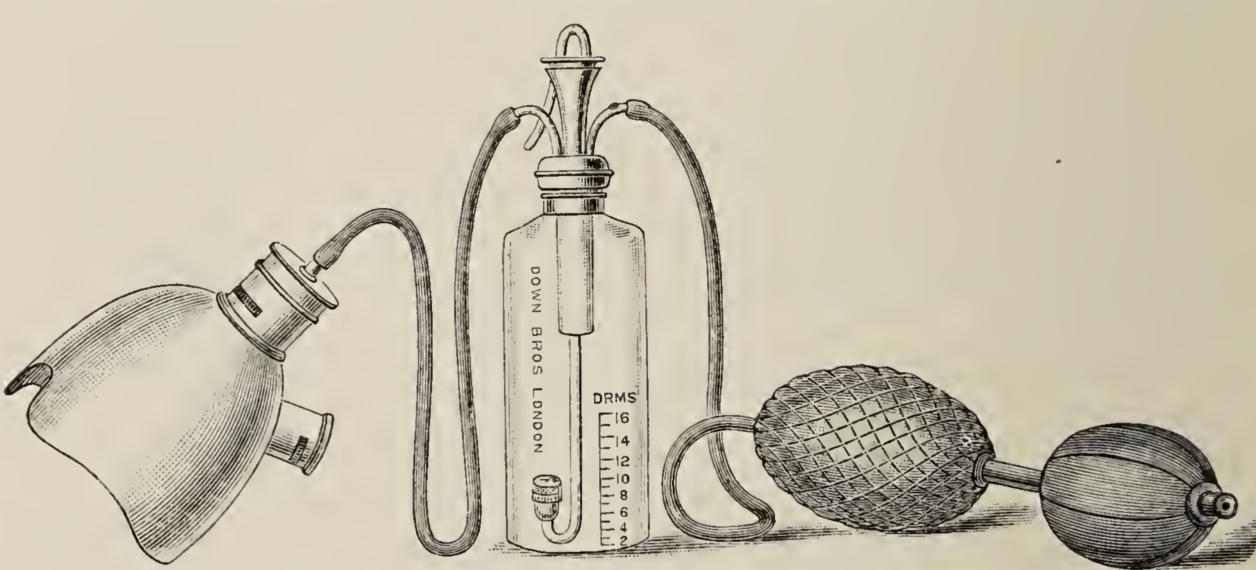

Fig. 321.—Junker's Inhaler.

a dilated pupil, an absent corneal reflex, and sweating are signs of overdose. On the other hand, shallow breathing, with pallor, a small pupil, and a perceptible corneal reflex, generally mean that anæsthesia is too light, and that vomiting will begin if the lips are not briskly rubbed to stimulate respiration, and more chloroform offered for inhalation.

After the drop-bottle and open mask, the next most generally applicable method of giving chloroform is by means of *Junker's inhaler* (*Fig.* 321). This instrument is of particular service, is indeed indispensable, unless substituted by Shipway's apparatus, in giving a continuous supply of chloroform during the performance of long operations upon the tongue, nose, pharynx, etc., when a mask cannot be held over the face without interfering with the surgeon. On such occasions the chloroform vapour is pumped through a metal tube placed on the tongue well back at one side of the mouth, or along a soft catheter inserted through a nostril till its end in the posterior nares just overhangs the upper aperture of the larynx

Soft catheters are used with special mounts for fitting on the rubber tube of the Junker. In cases where this method is required, the patient is first to be put under chloroform to the degree of surgical anæsthesia, and then, before operation is begun, the anæsthetist tests the efficiency of his nasal or intra-oral means of continuing the anæsthesia. If, without doing this, the operation is begun during a comparatively light anæsthesia, and then, with the mouth open as is generally the case in these instances, the anæsthetist inserts his catheter, he is apt to find it impossible to attain the necessary depth of narcosis by his Junker. When the Junker is used for ordinary cases the tube or catheter is replaced by a light mask covered with lint or domette. This is held in front of the nose and mouth, and with each inspiration of the patient the indiarubber ball of the instrument is gently compressed. Weak squeezes are to be used at first, and, as the patient gets accustomed to the very faint vapour of chloroform applied, the strength of this is increased, the mask allowed to rest upon the face, and finally after three or four minutes the ball is squeezed nearly flat with each inspiration and the full strength of vapour given that the instrument can supply. *Before using a Junker, it is important to see that the rubber parts are pliable, a little dry warmth being applied to them if they are stiff, and also that the connections are properly made and that it is impossible for liquid chloroform to be pumped up and reach the patient.* Also through allowing the bottle to be much tilted during administration an anæsthetist has incurred this accident, with grave damage to his patient.

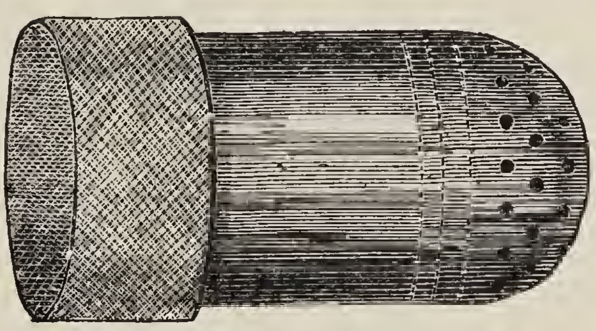

Fig. 322.—Rendle's Inhaler, with Flannel Bag holding Sponge.

Reference has been made to the value of the *C.E. mixture* (chloroform two parts by bulk, ether three parts), which, as regards method of administration, may be held to include the *A.C.E. mixture* (alcohol one, chloroform two, ether three parts). The best method of administration is the same as that described in connection with chloroform given by the drop-bottle and mask. The principle of gradual administration with free air-supply is to be just as rigidly observed, but larger quantities of the agent are required than with pure chloroform, and in the case of a robust subject it is well to have two layers of material instead of one upon the mask. If even this prove insufficient, as shown by too slow approach of unconsciousness or too prolonged a stage of muscular excitement, use Rendle's (*Fig.* 322) or Allis's inhaler. With these instruments the air-supply is to some extent curtailed. They are used by pouring a couple of drachms of the mixture upon the sponge and renewing as frequently as the dryness of the sponge shows to be necessary. By means of the perforations at the top of the Rendle inhaler, the mixture may

be added from the drop-bottle without removing the inhaler from the face.

Care of the Eyes.—Whenever a drop-bottle and open mask are in use, whatever the anæsthetic, special care is necessary to guard the eyes from damage. This arises easily either: (1) From admitting drops of anæsthetic to the open eye; (2) From touching the anæsthetic eye with the finger or with the edge of the mask or free pad; or (3) From contact of the anæsthetic eye with the anæsthetic vapour. The golden rule is to be sure that the eyelids are completely down during operation, and to test the eye reflexes with the finger as seldom as possible, if at all, after anæsthesia is once established. Many instances of conjunctivitis and even of corneal ulceration follow anæsthesia, and are almost always avoidable.

Ethyl Chloride.—The indications for use have been briefly mentioned, and a few words may be said in explanation of the way in

Fig. 323.—Ethyl Chloride from bag of Clover's Inhaler.

Fig. 324.—The same—Middle of Administration.

which to give this drug. It is supplied in tubes of various kinds, the best-fitted perhaps being those of Duncan, Flockhart & Co. The tubes are graduated in cubic centimetres, and generally speaking the dose to be used for a child up to four years of age should be 2 c.c.; up to ten years, 3 c.c.; for older children and women, 4 c.c.; for men, 5 c.c. The patient may be in the lying or sitting position. A small mouth prop, or Doyen's gag, in tonsil or adenoid cases, is to be put between the teeth before beginning. The dose to be used is sprayed into the small bag with the tap-fitting described in connection with the use of ethyl chloride and ether (*Fig.* 323). This bag fits straight into the face-piece; the patient is asked to breathe quietly, and the face-piece being gently applied and expirations being seen to distend the bag, this is raised till, at the end of the third breath, it is in a line at right angles to the face (*Figs.* 323, 324).

Unconsciousness is induced with remarkable rapidity. Often two breaths in the case of a child, and three or four with an adult, when the face-piece is accurately adapted to the face so that no air is admitted, are enough to abolish consciousness. Stertor is not always present, and the fixed globe of the eye, with absent conjunctival reflex and dilated pupil, are the signs of anæsthesia. The average duration of anæsthesia is about seventy-five seconds. Recovery is rapid, but is more often associated with sickness or headache than in the case of nitrous oxide. If several minutes' anæsthesia are required, three breaths of air are to be admitted every three breaths, and more ethyl chloride squirted into the bag, 2 c.c. at a time. After administration, the face-piece should be thoroughly cleansed and the bag washed out with warm water. The great convenience of ethyl chloride must not blind us to the fact that it has been associated with many fatalities, and that therefore, when nitrous oxide meets the case, this should be chosen. Safety with ethyl chloride is best assured by care in strictly limiting the amounts used and in giving breaths of air with sufficient frequency. Ethyl chloride may be used upon an open mask as a preliminary to C.E. or open ether in the induction of anæsthesia. Such use is of great advantage in the case of a frightened child, as unconsciousness is very quickly obtained. The drug can be squirted freely into an open mask, for there is little chance of overdosage owing to the extreme volatility of ethyl chloride.

Rectal Administration of Paraldehyde or of Avertin.—These two drugs, used as preliminaries to a further anæsthetic, are often actually the main cause of narcosis. They can be used with great advantage in the case of highly nervous or apprehensive people, of exophthalmic goitre subjects, and of children. The rectal injection is made in bed at least half an hour before the time of operation, the result being that the patient is rendered so drowsy that he has no realization of any inhalation anæsthetic that it may be necessary to administer. Full anæsthesia is not aimed at either by paraldehyde or by avertin. The latter is given in doses of 0·1 grm. per kilo of body weight, and paraldehyde in doses of one drachm per stone of body weight. For full details of the methods the reader is referred to the *Lancet*, March 16, 1929 (avertin), and the *Proceedings of the Royal Society of Medicine*, March, 1929 (paraldehyde).

ANOCI-ASSOCIATION.

A few words are necessary with regard to the combined method of anæsthesia introduced by Crile under the above title. The object of this method is the abolition of all causes of shock. Thus psychical shock is avoided by preliminary hypodermic injections of morphia and atropine, and if necessary by rehearsals imitating the induction of anæsthesia without actually producing it. The shock caused by peripheral stimulation is combated by the free use of local injections, novocain into the skin and into successive layers of tissue, and quinine

and urea chloride into the peritoneum for its more lasting effect and abolition of after-pains; general anæsthesia by nitrous oxide and oxygen or by open ether is employed to maintain unconsciousness and complete the safeguard against psychical shock. To ensure muscular flaccidity, repeated local injection is relied on rather than increasing the dosage of the general anæsthetic. The method lightens the responsibilities of the anæsthetist just as it increases the labours of the surgeon; but the results achieved are most satisfactory from the patient's point of view.

CONDITIONS OF DANGER.

When conditions of danger arise during inhalation of an anæsthetic their presence is shown by failing respiration or circulation, or both. The first steps to be taken are: (1) Withdraw the anæsthetic; (2) Stimulate respiration by briskly rubbing the lips and face with a towel; and (3) Lower the head. If respiration actually stops, (1) Compress the chest twice with a hand pressed against each side from the front; (2) Lower the head, open the mouth, and draw out the tongue; (3) Pass a finger to the back of the pharynx, making sure that the epiglottis is not causing obstruction of the larynx. If breathing does not now start again, give care of the tongue to someone else and start systematic artificial respiration by Sylvester's method. Stand well over the patient and use your weight to give effective pressure.

It is important to perform artificial respiration with sufficient slowness. The complete movement should be carried out at a rate of not more than eighteen to the minute. Effective artificial respiration is the most important remedial measure in anæsthetic collapse, and the anæsthetist should give it his whole attention. While he is thus employed, injection of strychnine or of adrenalin may be made by someone else if thought advisable. When artificial respiration fails to restore animation after five minutes, *massaging the heart* should be tried. In the case of children this is to be effected by means of a hand placed over the region of the heart and another pressing up below the left costal arch. With the comparatively rigid thorax of an adult such a procedure is useless unless the subject is very thin. If the operation is one for which the abdomen is already open, the heart may be massaged by fingers pressing upon it from below the diaphragm. Such a measure has succeeded where all else had failed. The abdomen has on several occasions been successfully opened for the express purpose of massaging the heart. Intracardiac injection of adrenalin has also been successful in restarting a heart after all other measures had failed. The injection should be made just above the fourth intercostal cartilage about half an inch from the sternum.

In cases of shock during operation, transfusion with saline solution is often of great service, and the anæsthetist should always have at hand a simple apparatus by which the injection may be made

subcutaneously or, if thought necessary, into the veins. The prevention of shock by properly conserving the heat of the body, and by continuous subcutaneous administration of saline from the start of the operation, is more effective than any method of treating this condition when it has arisen.

AFTER-EFFECTS.

Next to care in the selection and administration of anæsthetics, the most important point with regard to the patient's satisfactory recovery from their effects is to move him as little and as gently as possible till consciousness is completely restored. Generally speaking, no solid food is to be allowed during the first twelve hours after operation, and only small quantities of thin liquid, such as tea, which is often found the most welcome beverage to start with. If retching or vomiting continue, a drink of 20 grains sod. bicarb. with a like amount of sal volatile in half a pint of water should be swallowed. This will generally cause an urgent and final vomit. Many surgeons give a rectal injection of potassium bromide and aspirin in water (about 20 gr. of each) to all adult patients before consciousness has returned. In nervous persons in whom retching persists, an enema of potassium bromide or a hypodermic injection of morphia is to be employed.

SPINAL ANÆSTHESIA.

This method of inducing anæsthesia over the lower abdominal and lower extremity areas is largely practised. It is one which has a distinct value for operations upon these regions when the condition of the patient is such as to render the employment of a general anæsthetic a matter of considerable risk and danger : as, for example, in serious cases of peritonitis, or when the patient is suffering from pulmonary and cardiac weakness, and in severe crushes of the lower extremity. Severe diabetes is another condition which renders inhalation anæsthesia undesirable and in which spinal injections are often employed with success. The method is not invariably successful, though in all probability the failures result rather from imperfect technique than from the want of anæsthetic power with the drugs employed. When first introduced cocaine was injected, but the toxic properties of this drug being greater than those possessed by novocain and stovaine, most surgeons prefer to use these substitutes. The drug may be used in normal saline solution, with or without the addition of suprarenal extract. Stovaine is at present the drug most favoured by those who frequently practise the method, and the combination of this with glucose and distilled water in hermetically sealed ampoules (Barker) is as convenient and efficient a spinal anæsthetic as is available. The usual dose of stovaine is from 3 to 6 cgrm.—i.e., 2 to 3 c.c. of the contents of the usual ampoule ; Hughes

prefers a solution of 5 per cent stovaine with 10 per cent caffeine citrate and sodium benzoate in distilled water. The strength of novocain is usually 5 per cent, of which 3 c.c. to 8 c.c. may be injected according to the extent of the operation. If weaker solutions are used, larger injections are to be made. The technique is as follows :—

The patient is seated on the operating-table, and the lower part of the lumbar spine is carefully cleaned and sterilized. The highest point of the iliac crest is taken on either side, and these two points are joined together by a transverse line. This line corresponds to the position of the fourth lumbar spinous process. A long exploring needle is now taken, the best being one of platinum-iridium, about 12 cm. long and 1 mm. in diameter. The patient is directed to bend forward and make a 'great back,' and the puncture is made either at a level between the fourth and fifth spinous processes, or between the third and fourth. If the back is sufficiently arched the middle line may be entered, but many surgeons prefer to introduce the instrument slightly to the side of the middle line, so as to avoid the veins. The needle is pushed home until a loss of resistance informs the operator that the spinal theca has been entered, which will usually take place at a depth of two to two and a half inches. It may be necessary to alter the direction of the needle if it strikes against bone, and even occasionally to withdraw it altogether and re-introduce it. For general purposes it may be said that it should be directed slightly upwards from the point marked out on the skin. As soon as the needle has entered the theca the cerebrospinal fluid, clear and limpid, should escape drop by drop. The syringe is now attached to the needle, and a quantity of cerebrospinal fluid, equal to the amount of the anæsthetic solution which it is proposed to inject, should be withdrawn. In this way a sudden increase of the intraspinal pressure is avoided. The needle is disconnected from the syringe, the cerebrospinal fluid emptied out, and the measured quantity of novocain or stovaine solution drawn up into the barrel. The syringe is reconnected to the needle, and the solution slowly injected into the spinal canal. The needle is then withdrawn and the puncture sealed with a dressing. The patient is now placed upon his back, with the shoulders raised on a pillow, so that the anæsthetic does not gravitate towards the vital parts of the spinal cord. If necessary, the buttocks are somewhat elevated to allow the drug to exert its effect upon the lower dorsal nerves. Anæsthesia is established in five to ten minutes, and lasts on an average three-quarters to one and a half hours. Sometimes when the needle is introduced blood flows freely from it. This is due to injury of a vein, and the needle should be withdrawn and re-introduced. Certain complications occasionally attend the use of this anæsthetic. They are headache, vomiting, and more rarely collapse ; but those surgeons who have employed it extensively speak in high terms of its value. There are many different ways of performing the injection, but two principles are common to them all : (1) That absolute asepsis should

be maintained ; and (2) That a quantity of cerebrospinal fluid equal to that of the anæsthetic injected should be withdrawn.

The injection is often more conveniently made with the patient lying on the side rather than in the sitting position. People who are feeble should not be sat up for the injection. When the lateral position is chosen, the legs and thighs are to be fully flexed and the head and shoulders bent forwards so as to secure as wide a space as possible between the vertebral processes. Untoward symptoms after spinal injection are generally due to the lowered blood-pressure brought about. For this reason it is important not to keep the head and shoulders raised more than five minutes after the injection has been made—indeed, the Trendelenburg position can be employed with advantage after this period of time.

LOCAL ANÆSTHESIA.

Local anæsthesia consists in injecting by means of a hypodermic syringe a solution of cocaine, stovaine, or novocain, in order that small operations may be performed without discomfort to the patient. As a matter of fact many major operations can be carried out successfully under local anæsthesia, though the method requires a certain amount of practice before it may be employed efficiently, even in minor surgery On the whole, novocain in a 1 per cent solution gives the most satisfactory results. It may be combined with advantage with adrenalin at a strength of 1–10,000, which limits the anæsthesia more strictly to the site of injection. The injections may be made either: (1) To infiltrate the tissues to be operated on; or (2) To surround and penetrate the nerves supplying the area of operation. The latter process is described as 'regional anæsthesia'. Commonly a combination of these two methods is employed. The technique is as follows :—

The skin over the affected region having been carefully prepared, a fine hypodermic needle connected with a syringe filled with novocain solution is introduced into the skin. It is necessary to see that the needle at first does not enter the subcutaneous tissues, since the sensitive part is the papillary layer, which should be anæsthetized first. If properly introduced, the injection of a few drops of the solution will cause a blanching of the skin and the formation of a round or oval swelling, '*la boule anœsthétique*.' The needle is then pushed on, its course running nearly parallel with the surface, until successive regions in the neighbourhood of the original puncture are anæsthetized ; and in this way, by altering the direction of the needle either to the right or left, a considerable area can be rendered completely insensitive by a single puncture. If wider effects are desired, the needle should be withdrawn and re-introduced at the margin of the last anæmic point, until the whole region likely to be exposed by the primary incision has been anæsthetized. Usually not more than 15 or 20 minims will be required for this. If it is necessary in the course of the operation

to proceed deeper, the needle is now thrust into the subcutaneous tissues, and 10 to 20 minims are allowed to penetrate more deeply. If the operation is performed upon an extremity, the position of the main nerves should be located, and the needle introduced as near them as possible, the fluid in this way being injected round the nerves which will chiefly affect the sensation of the patient. In the case of whitlows it is often sufficient to inject a few drops of a 1 per cent solution in the position of the digital nerves in order to render an operation for the relief of the condition perfectly painless. Absolute asepsis must be maintained, for it is in small operations of this kind that carelessness is apt to lead to the introduction of septic organisms. The best syringes for local and spinal anæsthesia are those composed entirely of glass, which can be thoroughly sterilized by boiling.

SECTION XI

MISCELLANEOUS

CHAPTER LI

OF THE PREPARATION OF PATIENTS FOR OPERATION, AND THEIR AFTER-TREATMENT

THE PREPARATION OF PATIENTS FOR OPERATION.

IN the case of an operation upon a child, the house surgeon should always be sure that the parents, or responsible relatives, understand and consent to its performance. In many cases it will be found much harder to gain this consent than if the operation had to be performed upon the persons of the parents themselves. With most hospital patients argument is of little avail, and a plain statement of the facts and issues of the case will be found to outweigh any eloquence. The ward sister will also be found an invaluable auxiliary in cases where persuasiveness is required.

No operation should ever be performed on an adult without his consent, and here also tact will be required ; patients much more commonly object to come into a hospital for an operation, than refuse to undergo it when it is put to them after they have been in the wards a short time, when they have learned to know and trust the surgical and nursing staffs, and to recognize that the large majority of patients operated upon recover. It is therefore sometimes wise to defer the question of the necessity of an operation until the patient has been admitted for a little time, and has become used to the ward.

But although a patient may be so far managed for his own benefit, mere good faith demands that in all cases the necessity or desirability of the operation, its possible results, and its risks, should be fully explained to every person before they submit themselves to it, and neither honesty nor policy demands that its importance should be minimized. We do not mean by this that any view but the most cheerful one should be taken. It is not wise or necessary, for example, that a woman with a scirrhous growth in the breast should have the statistics of recurrence forced upon her attention, but the facts should rather be emphasized that life is undoubtedly prolonged, and health and comfort retained, by an operation which is not in itself dangerous, and that complete removal has resulted in permanent cure.

In women, the date of an operation should be arranged to fall as far as possible from a menstrual period, unless they have ceased to

menstruate, but in cases of urgency the flow of the menses should not be made a bar to the operation.

Of recent years far more attention has been directed to the preparation of patients before operation, and there can be no doubt that the improvement in surgical statistics has resulted in no small measure from this practice. In the first place general measures which are applicable to most operations will be considered, and later the special treatment of diseases of certain parts—head, mouth, etc.

General Treatment.—Preparations for all operations should have certain definite objects in view, viz., to raise the resistance of the patient so that he may support what is often a severe strain on his recuperative powers, to diminish the risk of sepsis, and at the same time to prevent shock and undue hæmorrhage. These are the cardinal principles of pre-operative treatment, and are applicable to every kind of operation.

We should feed the patient who is in poor health on stimulating and nourishing foods, and make free use of saline and other injections, to which reference will be made later. No operations but those of urgency should be undertaken if the temperature is raised above the normal.

The stomach should be empty before the administration of the anæsthetic, so that the vomiting may be controlled; but it is not necessary to starve or purge our patients in the drastic manner customary some years ago. Experience in emergency operations has shown us that these cases do just as well as those who have been elaborately prepared. An aperient such as a patient has been used to, or a small dose—6 to 8 dr.—of castor oil should be given forty-eight hours beforehand. Supposing the operation to take place on the Wednesday: early on Tuesday morning the oil or aperient is given. Except in rectal cases the enema may be omitted, but if the bowel appears still loaded, a small soap-and-water enema may be given on Tuesday evening. Drastic purgation is quite unnecessary, and is actually harmful. Nor is rigid starvation an advantage: quite the contrary; light diet—soup, eggs, milk, and custards—can be permitted to within four hours of an impending operation without fear. The ordeal of an operation is quite enough for most patients without the discomfort of hunger being added to it. Post-operative vomiting, which is a symptom of acidosis, may be diminished or prevented by giving glucose (or, more simply, barley sugar) for twenty-four hours before operation.

Preparation of the Skin.—There are many different methods in use for the preparation of the skin, some surgeons avoiding antiseptic compresses altogether. Without entering into a discussion on this subject, we shall describe a method frequently employed, which can be modified according to the wishes of the surgeon in charge of the case.

Two days before the operation the part is thoroughly scrubbed

with soap and hot water ; if necessary the hair is shaved over the region of the operation. The soap is washed away with fresh water and the part is dried. It is next wiped over with a swab soaked in turpentine, and this turpentine in turn is removed with ether or absolute alcohol. A dry cyanide gauze dressing, or, if preferred, a compress (i.e., a layer of lint) soaked in 1–60 carbolic or 1–2000 biniodide of mercury, is placed on the skin, covered with protective and wool, and the whole is firmly bandaged.

On the day preceding the operation, the patient may have a warm bath, and the preparation should be repeated in detail as before. If the bath is omitted the compress should be changed.

Before the operation is begun, the whole area should be well washed with ether soap and dried. A final swabbing with a sponge soaked in biniodide of mercury in spirit 1–2000 completes the toilet.

The iodine method is now usually employed, with excellent results. The skin is shaved, if necessary, and painted with : (1) benzene, (2) acetone, (3) iodine 2 per cent in rectified spirit. This is done the day before the operation, and the solutions may be reapplied the same night. No compress is necessary. When the patient is on the table, the wound area is again painted with iodine. This method does away with the need for preliminary dressings, is entirely adequate, and it enables the surgeon to see that a sufficiently wide area has been prepared.

The Prevention of Undue Hæmorrhage during the Operation.—It is obvious that this is mainly in the hands of the operator and his assistant ; nevertheless a good deal can be done by preliminary treatment to check its occurrence.

In cases of jaundice, which are very liable to bleed profusely, or in operations where a large number of vessels may be cut, chloride of calcium or lactate of calcium should be given.

Chloride of calcium, however, must not be used indiscriminately in cases where much bleeding is expected ; for if large doses are given to a patient whose 'coagulating power' is high, there is considerable risk of thrombosis setting in. It is always advisable to test the coagulation period of the blood in any case before the drug is given. Horse serum in doses of 2 to 4 c.c. is also of great value.

Shock.—To obviate the shock of a prolonged and serious operation we have many measures at our disposal : see Chapter V, on 'Shock.'

THE PREPARATION OF SPECIAL CASES.

Operations on the Head.—We are generally concerned with two classes : the emergency fracture, and the tumour or abscess which permits of more leisure in diagnosis and treatment.

The fracture may be simple or compound ; if the latter, we have no option but to proceed at once with the operative treatment which may be necessary ; but if there is no open wound, and the symptoms,

although calling for operation, are not urgent, it will be wise to postpone matters until the head has been carefully cleansed.

In all cases where there is no immediate demand for operative proceedings, but where there is a prospect of their ultimate employment, the whole head should be washed and shaved, and efforts made with lotions and compresses to promote asepsis some days before the operation is undertaken. The ordinary wash, shave, and brush-up which are often pushed through at the last minute, are entirely inadequate to the needs of the case.

The Mouth and Tongue.—Care should be taken with these patients to get the mouth thoroughly clean. Carious teeth should be extracted, and those remaining, if covered with tartar, should be scaled or thoroughly well brushed. The mouth should be washed out several times a day with alternate solutions of bicarbonate of soda 20 gr. to the ounce and carbolic acid 1–100, or any other suitable antiseptic.

For this purpose, both before and after operation, an irrigator should be used which is suspended above the head of the patient's bed. This irrigator is filled with the required antiseptic solution. A long tube controlled by a clip and ending in a glass nozzle is attached to the irrigator. The patient can now irrigate his mouth at frequent intervals without trouble. He introduces the nozzle into the mouth, releases the clip, and a good flow of fluid ensues. The head is held over a bowl, and the fluid runs out of the mouth into it. This method is thoroughly efficient.

There is no doubt that careful attention to oral hygiene diminishes the risk of septic pneumonia, the most dangerous and common complication of operation upon the mouth and throat. Not less than a week should be spent in this preparation if the mouth is unclean.

The Abdomen.—The patient should be confined to bed for a few days beforehand : the actual number must depend upon the operation to be performed and the condition of the patient. The practice of 'rushing' patients into the theatre is to be strongly condemned. When a patient is about to undergo a serious abdominal operation, a week should be spent in properly preparing him. It is not necessary that he should be confined to bed all this time, but he can gradually become acclimatized to his new condition. Again, apart from the ordinary aperient, it is advisable to administer drugs that have some influence upon intestinal decomposition, e.g., salol, β-naphthol, and cyllin (one of the best intestinal antiseptics), especially if there is likely to be some interference with the intestine. As to the merits of these intestinal antiseptics there is some difference of opinion ; but if they are capable of inhibiting bacterial activity, even though they are not able completely to eliminate the micro-organisms, they should be employed.

The diet should consist of foods which are easily assimilated, and which leave little residue. It is not necessary to starve a patient

before abdominal section, but indiscreet dieting may cause a great deal of trouble afterwards.

Gastric cases usually require gastric lavage once or twice before operation, and it is well to feed them on sterilized foods for twenty-four hours beforehand.

The Rectum.—Under this heading such cases as complete excision of a cancerous growth will be considered. When any operation which aims at obtaining primary healing of a wound in the anal and rectal region is attempted, preparation must be most carefully undertaken.

It is not sufficient to administer a purge a day or so beforehand, and to conclude that the bowel has been emptied, nor to give an enema on the morning of the operation and imagine that the rectum has been cleansed.

In many of these patients there is a considerable amount of obstruction : not enough perhaps to give rise to distinct symptoms, but sufficient to prevent the bowels acting freely, the result being that there is sometimes an action very shortly after an operation has been performed in the rectal region.

Petersen has shown that the worst accident that can occur during the after-treatment of cases of excision of the rectum is an attack of diarrhœa ; if this occurs, fæcal matter is forced into the various recesses of the wound before protective adhesions and granulations have had time to form.

Many Continental surgeons who have had a large experience of rectal surgery prepare their cases as follows : Some eight or ten days before the date fixed for operating, the patient is admitted and is thoroughly purged, a process which extends over three days, after which the bowels are kept at rest by the administration of bismuth and opium before and for some days after the operation.

A diet is given which will leave a minimal residue, and at the same time have a maximal stimulating effect, such as meat extracts, raw meat juice, peptonized milk, fish, and eggs. Each morning the rectum is well washed out with a weak solution of permanganate of potash, and some ammoniated mercury ointment is applied to the anal region. With some slight modifications we may accept this as the best form of pre-operative treatment for rectal cases. Where a severe operation is to be performed, if treatment starts six days prior to the operation it will be sufficient ; and the bismuth and opium should be combined with salol two days before and three days after the operation :—

℞	Bismuthi Subnitrat.	gr. xx	Tinct. Cardamomi Co.	ʒss
	Tinct. Opii	♏iv	Aq. Chlorof.	ad ℥j
	Salol	gr. x		

Fiat mist. Two tablespoonfuls three times a day.

For simple cases of hæmorrhoids the general treatment previously described is adequate, but the enema must not be omitted. Half an hour before the operation a suppository of morphia and belladonna, $\frac{1}{2}$ gr. of each, is introduced. It is unwise to give an enema

within six hours of a rectal operation. In cases of fissure it is needlessly cruel to purge a patient ; a small local operation alone is required, and he need not be subjected to the torture of aperients and enemata at all.

The Genito-urinary Tract.—We consider here operations upon the kidney, bladder, prostate, and urethra—a large and very important group of surgical cases. In the majority of patients who suffer from extensive disease of these organs the renal function is impaired. There can be no doubt that the simplest operative procedure makes serious demands upon the tissues of the body, especially upon the kidneys, and unless they are moderately healthy, they will be unable to stand the strain.

It is no unusual occurrence for a patient who has been subjected to an operation for the relief of stricture or for prostatic enlargement to succumb within a few days from suppression of urine. In most cases this complication is due to previous damage to the kidneys, and the shock of the operation, and possibly other factors, such as acute urinary infection, have combined to bring about a most serious state of affairs. In order to prevent this as far as possible, pre-operative treatment must be very carefully carried out.

If definite evidence of renal damage is forthcoming in the shape of a dry skin, bilateral renal pain and tenderness, thirst, and a diminished excretion of urea, all operations but those of urgency should be deferred.

The patient should be confined to his bed or house for some days before any operation is attempted, and he must be warned to avoid draughts and chills.

Milk, fish, and eggs are the best diet ; meat should be given sparingly. If stimulants are required, whisky or gin appears to be most suitable. The skin must be made to act by warm baths and friction, since by its vicarious action the kidneys can be relieved of a considerable amount of work. The patient should drink at least two pints of barley-water or lemonade during the day. Contrexéville or Vichy water should be given as a routine.

The bowels must be made to act well : they are often sluggish in this class of case. If pus is present in the urine, quinine, hexamine, and acid sodium phosphate may be given ; if there is much tendency to phosphatic deposit, nitrohydrochloric acid should replace the latter drug.

Digitalis and strychnine are also valuable drugs for stimulating a failing kidney.

If the bladder is very foul, it will be necessary to wash it out regularly twice a day, or even to open and drain it, in those cases where the more serious step of removal of an enlarged prostate is contemplated.

Finally, before any serious operation on the urinary tract is contemplated, the functional output of the kidneys must be estimated by one of the various methods in general use.

POST-OPERATIVE TREATMENT.

It is obviously beyond the scope of this work to deal with all the various details of post-operative treatment, or with the many complications that may arise during the progress of the case, and only the more important points will be considered. (The two serious complications, hæmorrhage and shock, have already been mentioned.)

In the general management of a case after an operation has been performed, the following details will require attention.

Return to Consciousness.—While the effects of the anæsthetic are passing off the patient must be very carefully watched. In the state of stupefaction before consciousness has fully returned, patients may try to get out of bed, and do themselves serious damage. The vomiting which is usual at this period must be looked after, the head being turned on the side, and the opposite shoulder raised so as to assist the expulsion of the vomited matter. If this care is not taken, the vomit may be sucked down the trachea into the lung.

Position.—The particular position which a patient should assume depends upon the operation that has been performed, and upon other considerations—age, etc. In the majority of cases the patient is placed on his back, with the shoulders and head slightly raised—the supine position ; this is usually chosen for an ordinary abdominal case. A pillow should be placed under the knees so as to flex them slightly and take the tension off the abdominal muscles. It is becoming more and more usual to nurse all abdominal operation cases in the sitting-up position, and many ingenious methods have been contrived to add to the comfort of patients in this position.

In cases where special drainage of an abscess, e.g., an appendicular abscess, is required, or to facilitate the flow of the contents of the gall-bladder in cholecystostomy, the patient is usually placed on his side with a pillow supporting the back—the lateral position.

If the patient is suffering from severe forms of peritonitis, it is now the practice of all surgeons to prop him up in bed (Fowler's position) so that the fluid exudate can gravitate towards the pelvis and escape along the pelvic drainage tube. (This treatment is usually combined with the continuous administration of saline per rectum.) A similar position should be assumed if there is any tendency to chest complications, as the lungs and heart are better able to work in this position in cases of hypostatic congestion or bronchitis than when the patient is flat on his back.

If any difficulty is experienced in maintaining this attitude, a pillow should be placed beneath the thighs, the knees being flexed over it, and it should be secured by strong cords to the posts on either side of the head of the bed. In this manner it acts as a sling, and keeps the patient from slipping down.

If there is a wound of the back or buttock, the patient should be put in the prone position. Although at first there may be some

inconvenience in maintaining this unusual posture, it is wonderful how soon patients get accustomed to it. Such a position markedly facilitates the draining of abdominal abscesses, and may be rendered necessary by the development of bedsores during the course of a case.

In whatever position the patient is placed, it is very necessary to see that as far as possible comfort is obtained. We are not now so strict as to the movement of cases after abdominal section as formerly, and many surgeons will allow their patients to be turned on to the side if that position gives greater ease, rather than compel them to pass a night of discomfort in the position of orthodox supination.

In children it is even more important not to impose any unnecessary restraint which is likely to make them restless and irritable, and they may be allowed to move about fairly freely. One note of warning must, however, be sounded in this respect. Children do not stand abdominal operations well, and there is often some need for hurry towards the end of an abdominal section ; this may result in the wound being closed by a single layer of sutures. There seems to be a greater tendency for the abdominal contents to protrude in children than in adults, and if the case is not watched, the house surgeon may find some coils of intestine prolapsed through the abdominal incision. This is a fairly common complication after an operation for intussusception. It is always advisable to apply a broad piece of strapping over the first layer of dressings in such cases, to prevent this accident.

Sleeplessness and Pain.—The importance of adequate rest during the treatment of surgical lesions must be fully realized. Although a patient may be free from severe pain he may be unable to sleep, either because of the position which he is compelled to assume, or because of his general surroundings. If a patient passes a restless and sleepless night, he cannot make satisfactory surgical progress. These remarks are not to be taken as a suggestion that every patient who suffers from sleeplessness is to be deluged with soporific drugs, for there are other means of attaining our ends. Emphasis has already been laid upon the importance of a comfortable position, and a house surgeon should see that splints, bandages, etc., are in good position and not unduly tight.

In the satisfactory treatment of his cases, a house surgeon must steer between two extremes : the one of giving sedatives too readily and over too long a period, and the other of withholding rest- and sleep-giving drugs from a patient who is restless and in pain.

Solutions of opium or nepenthe are frequently of much more value than morphia, and should often be employed in preference to this latter drug. Omnopon is an excellent substitute for morphia, and produces few bad effects.

It must be remembered that morphia, although a sedative, does not always produce sleep : the drug may lull the sensibility of the patient to pain without producing further action ; but if in addition to a hypodermic injection of 4 to 8 min. morphia, chloral hydrate 7 to

10 gr. or potassium bromide 10 to 12 gr. be administered, pain will be diminished and sleep induced.

Morphia must be given with the greatest care in abdominal cases, since it tends to produce tympanites from its paralysing action on the bowel wall. The indications for its use are : severe pain which cannot be controlled by local measures such as fomentations to the abdomen, great restlessness, and persistent vomiting. In such cases it should be begun in conjunction with atropine :—

℞ Liq. Morph. Hypoderm. ♏iv–viij | Liq. Atrop. Sulph. ♏j
Fiat injectio.

Sometimes aspirin (acetylsalicylic acid) in 10-gr. doses has an excellent effect on the pain caused by abdominal lesions.

Children are very susceptible to the action of opium and its alkaloids. Following an operation for intussusception, two to three 1-min. doses of the tinct. opii may be given to a young child to keep the intestine quiet, but in most other cases it should be withheld.

As a substitute for morphia, medinal may be employed in 5- to 10-gr. doses. It seems a satisfactory drug in small doses.

In cases of septicæmia or severe intoxication, a pill containing opium 1 gr., quin. sulph. 3 gr., is very satisfactory.

The use of these drugs must be discontinued as soon as possible. If a patient seems to depend too much upon them, and if the pain has greatly diminished, a harmless deception may be practised, namely, the administration of a hypodermic of distilled water instead of a solution of morphia. This injection will often act by 'suggestion,' and patients will sleep quite peacefully after its administration.

As a routine in all abdominal cases, 20 gr. of bromide of potassium and 20 gr. of aspirin are given by the rectum. The aspirin is dissolved in ½ oz. of brandy, the bromide is added, and a little saline makes up a sedative enema of 2 oz., which has a most beneficial effect on the spasmodic muscular pain of an incision.

Stimulants are drugs which increase the patient's strength and power of resistance, and they are to be employed when there is a great drain on the vitality, as for example in cases of peritonitis or prolonged suppuration, or when shock is present as the result of injury or operation (*see* 'Shock,' Chapter V).

The value of strychnine as a stimulant has been previously discussed, and it will be well to repeat that when it has been thought advisable to employ it in doses of 3 to 5 min. every four or six hours for any length of time, it should not be suddenly discontinued, but the amount should be gradually diminished and the interval between the injections gradually increased.

Alcohol is a drug which is largely used by many surgeons as a stimulant or food. Such contradictory opinions have been expressed by great authorities that it is difficult to be at all dogmatic on the subject. On the whole, the use of alcohol in moderation is to be

advised, but it must be regarded as a drug, and not be administered indiscriminately. Few cases require more than four ounces of brandy during twenty-four hours. Alcohol may be given in various forms. Champagne is an excellent diffusible stimulant, very valuable in abdominal cases, and it has some effect in checking sickness. Cases of genito-urinary disease do not as a rule require alcohol, but should its use be considered necessary, whisky or gin is to be preferred to brandy. Alcohol may be given per rectum in saline enemata, but its introduction into the vein, even in small quantities, when saline infusion is undertaken, is not advisable. An excellent stimulant for a child is made up as follows :—

℞	Ammon. Acet.	ʒss	Sp. Ætheris		ʒiv
	Rum	ʒiv	Aq.	ad	℥iij

One teaspoonful every hour.

Oxygen is a very valuable stimulant, and after severe operations upon the abdomen it is good practice to order inhalations for two or three minutes every quarter or half hour. If the pulse is failing, the oxygen should be passed through absolute alcohol. This method was first suggested to us by Drs. Alcock and Collingwood, as the result of their experiments in the physiological laboratory, and it has been most successful in reviving a failing circulation. An ordinary wash-bottle is taken, and is connected on the one hand to the oxygen cylinder, on the other to the mouthpiece, and the gas is allowed to bubble through the alcohol, reaching the patient charged with alcohol vapour. This vapour is very pleasant to inhale, and is powerfully stimulating. In very cold weather oxygen should always be passed through warm water before the patient is allowed to inhale it, as the cold gas may irritate the bronchi and lungs. If the alcohol be employed, it can be warmed very easily by allowing the wash-bottle to stand in a bowl of warm water. In cases of emergency a 'Junker's' apparatus serves the purpose of a wash-bottle admirably.

Diet.—The diet of ordinary surgical cases presents little difficulty. Only the special diet required in abdominal cases and the details of nasal or œsophageal feeding will be considered.

Abdominal Cases.—No food should be given for the first six hours after the operation. If the patient complains of thirst, small amounts of warm water up to 2 oz. may be given. There is no need to adhere strictly to the old method of treatment, when only teaspoonfuls of warm water were permitted. Rectal salines will also be of service in checking the thirst. A weak solution of sodium bicarb., 1 dr. to the pint, is an admirable drink after abdominal operations : it allays the sickness, and is a preventive against acidosis.

Feeding may begin with small amounts of weak tea, milk, albumen-water, etc., and it is convenient to start with about 2 oz. every two hours, so that in the twenty-four hours the patient takes 24 oz. of nutritive fluid. It may be advisable to diminish or increase these

amounts, and such steps must depend upon the patient's condition. If the administration of food by the mouth excites vomiting, it must be discontinued in favour of rectal feeding ; but if the patient takes it well, at the end of the twenty-four hours the amount may be increased to 3 or 4 oz. With an increase in the amount to 4 oz. or over it is well to increase the intervals between the feeds, so that the patient gets food every three or four hours instead of every two. The best guide as to the way a patient should be fed is the way he takes and digests the nutriment. Even after the operation of gastro-enterostomy a patient will take food readily within twelve hours of the operation.

The various fluid diets suitable for abdominal cases are : (1) Milk ; (2) Albumen-water ; (3) Beef-tea ; (4) Plasmon foods ; (5) Raisin-tea.

Milk should not be given in its natural state in most abdominal cases, as it is apt to curdle in the stomach. It should be given in the form of peptonized milk, or citrate of soda should be added to it. Many patients cannot take milk, so that other foods must be selected.

Albumen-water is made by adding the whites of four eggs to one pint of water, mixing thoroughly, and adding a little lemon and sugar.

Beef-tea, even if prepared by prolonged soaking of fresh-cut meat in water, probably has little nutritive value. It is, however, very palatable, and many patients prefer it to milk. If the scraping of fresh raw meat (raw meat juice) be added to beef-tea or beef extracts, or to any plain soup, a very nourishing and stimulating food is produced.

Plasmon is a form of albumin which is easily digested. It is obtained in the form of a white powder, which can be added to beef-tea, milk, or cocoa, and is very satisfactory.

Raisin-tea is made by pouring half a pint of boiling water on to half a pound of chopped raisins and allowing it to stand. The water, which now contains a solution of grape sugar, is poured off and used as an alternative to the other foods mentioned.

A fluid diet must be continued for at least forty-eight hours in most cases, after which custards, jellies, bread and milk, and beaten-up eggs may be allowed. As a general rule, nothing of a more solid nature should be given until the bowels have acted. A 6 per cent solution of glucose is of great nutritive value—it can be added to the normal saline of a rectal enema, or if sterilized to the saline administered subcutaneously. Glucose can also be given by the mouth in the form of jellies.

When a severe operation such as gastro-enterostomy or enterectomy has been performed, the diet should be fluid for about a week. No definite rules can be laid down on this point, as many surgeons hold the view that the diet may with advantage be more generous in the early days after operation ; and it is better to rely upon the patient's general condition and on the manner in which food is tolerated in an individual case than to keep strictly to a hard-and-fast rule.

If a patient is fed by nutrient enemata, they should not be discontinued until at least 24 oz. are taken by mouth in the twenty-four hours.

Nasal and Œsophageal Feeding.—Feeding through the nose or the œsophagus is required after severe operations upon the mouth and throat, since the passage of food over the raw surface would be most injurious ; it is also required in some cases of tetanus, hysteria, and laryngeal disease in children.

Nasal Feeding.—A rubber tube with a blunt rounded end like a catheter, of sufficient length to pass into the stomach (16 in. for an adult), is dipped in glycerin and passed along the inferior meatus of the nose into the pharynx and thence into the œsophagus and stomach, if necessary—usually it is sufficient to pass the tube well down the œsophagus. Care must be taken that the tube does not pass into the larynx, an accident which is most likely to happen if the patient is under an anæsthetic, and which is immediately followed by a violent fit of coughing. A glass funnel is connected to the nasal tube by another piece of rubber tubing and a glass joint. The 'feed' consists of milk, beaten-up egg, and a little brandy. If preferred, beef tea and raw meat juice may be given. On the first occasion it is advisable to start with a very small amount (2 to 4 oz.), since the sudden introduction of a large quantity (10 oz.) into an empty stomach is likely to cause vomiting, and the very accident is caused which it was intended to avoid, namely, the soiling of the wound with food particles. For the same reason, as this accident may happen in spite of such precautions, the 'feed' should be sterile at first, and should consist of boiled milk or beef-tea and brandy. The feed should be given slowly, and the tube should be rapidly withdrawn, since by this manœuvre the œsophagus and pharynx are less liable to be stimulated. When the patient has become accustomed to this method, larger amounts (10 to 12 oz.) may be given every four hours (for an adult).

Œsophageal Feeding is performed in the same way, but the tube is introduced through the mouth, and must be made to impinge on the post-pharyngeal wall and guided past the larynx in the middle line into the œsophagus. Constant nasal feeding may make the nose sore, so it is well to alternate the two methods.

In tongue and mouth cases, as soon as power of swallowing is regained, a rubber tube should be fitted over the end of a feeder, and if the tube is passed well to the back of the mouth the patient may be allowed to swallow his food. It is always advisable to test the patient with a little water before giving him the food, in case he is unable to get it down.

The Management of the Bowels.—On the third evening after the operation an aperient should be given. Castor oil, 1 oz., is the drug usually employed, and it is a most satisfactory purge. It is, however, exceedingly unpleasant on account of its nauseous taste, and calomel 2 to 3 gr., followed by a saline draught in the early morning, may be used instead.

In simple uncomplicated abdominal cases, such as hernia, etc., the above routine treatment may be regarded as satisfactory, but in all cases where there has been much manipulation of the intestine, or where a certain amount of damage has been necessarily inflicted, such as in resection, anastomosis, etc., it is much better to depend upon an enema for obtaining an evacuation than upon an aperient.

Even when the appendix has been removed in a quiescent state it is better to start the action of the bowels by an enema ; as soon as this has acted, mild aperients—salines, cascara (4 gr.), or small repeated doses of calomel ($\frac{1}{2}$ gr.)—are given by the mouth. Some surgeons go so far as to keep the bowels absolutely quiet after these operations, giving neither aperients nor enemata ; but the discomfort of their patients seems a potent argument against this line of treatment.

Distention or meteorism will be considered among the special complications.

Retention of Urine follows and complicates many operations on the abdomen. Sometimes it appears to be a reflex condition, the vesical nerves being temporarily paralysed, as after operations on the rectum ; at other times it seems due to the dorsal decubitus.

This complication must be carefully considered and treated. It is quite unnecessary to have immediate recourse to a catheter ; milder domestic remedies should be tried. A hot bottle (rubber) or a fomentation should be applied to the hypogastrium, and a hot sponge to the perineum. Unless there is some special contra-indication, the patient may be turned on to his face, or even on to his hands and knees, a position which will materially assist the act of micturition. A drachm of spirits of juniper with warm water is sometimes of great value.

If these measures fail, a catheter must be passed. Every antiseptic precaution is to be observed, and its use must be discontinued as soon as possible. Women are exceedingly liable to develop cystitis when confined to bed ; how far the condition is dependent upon the use of the catheter has not been accurately ascertained, but many cases are due to this cause. The catheter is rarely required after the second or third day, but when it is discontinued it is very necessary to make certain that the bladder is properly emptied.

If a large pelvic tumour, such as a fibroid uterus, has been removed, a considerable cavity is left into which the bladder may prolapse. After the first few days of catheterization, the power of micturating returns, but the patient complains of pain and discomfort in the bladder ; these symptoms may signify cystitis, but they also may mean that the bladder is not being properly emptied. A catheter must be passed at once to clear up the doubt.

Thrombosis, or intravascular clotting, concerns us only insomuch as it may affect the veins, not only in the region of the operation, but at some distance from it.

Venous thrombosis in surgery is usually, but not invariably, associated with some degree of bacterial infection. If a patient with a sluggish circulation is placed on a too exclusive milk diet, there is some risk of thrombosis occurring. Sir A. E. Wright advises that when milk is being given in any large quantity, sodium citrate 10 to 20 gr. to the pint should be added.

If the venous clot is in a state of active suppuration, there is a great chance that embolic particles will be carried into the lungs and general circulation, with the result that septic pulmonary infarcts or pyæmic abscesses develop. In any case of bone suppuration the cardiac and pulmonary physical signs are to be noted carefully, as the first indication of a deep thrombosis may be a cardiac murmur or a patch of pulmonary dullness, with friction sounds, tubular breathing, and perhaps hæmoptysis. Even when signs of active sepsis are not present, the complication is a serious one. Pulmonary infarction (non-septic) may occur, and the sudden detachment of large particles of clot may cause very urgent dyspnœa, or even a fatal issue from blockage of the pulmonary artery.

In any large series of cases such accidents will be recorded, and they are the more distressing in that they often occur quite unexpectedly, when a patient is apparently getting on quite well.

Curiously enough, it is not the clots which excite the most symptoms that become detached as a rule, but the quiet unsuspected thrombi in the pelvic or ovarian veins, which are suddenly discharged into the circulation with a disastrous result.

In its ordinary form thrombosis usually attacks the veins of the extremities. The patient feels a pricking or itching in the region of the vein ; later a dull aching pain influenced by movement. The course of the vein is represented by an exquisitely tender cord ; possibly some slight reddening of the skin is present. The temperature is raised. If the clotting is extensive there will be swelling of the limb.

Treatment.—The development of an active septic clot is a very great source of danger to the patient, and it will be a matter for the visiting surgeon to decide whether any active measures are to be taken. Briefly they are two : (1) The ligature of the main vein to prevent dissemination—this principle is practised in the ligation of the internal jugular vein in cases of lateral sinus thrombosis—the septic clot is cleared out subsequently ; or (2) Amputation. In some cases of compound fracture with evidence of extensive thrombosis this treatment may be demanded.

In the simpler forms absolute rest must be enjoined. The patient must lie perfectly quiet, with the limb wrapped up in cotton-wool and protected by a cradle.

The best application is a long strip of cotton-wool shaped like a trouser leg, kept in position by a many-tailed binder. Glycerin and belladonna should be applied as a local sedative over the inflamed

vein. Under no circumstances is the patient to move, as the slightest effort may lead to the detachment of the clot.

Iron, nux vomica, and other tonics should be given when there is marked anæmia ; and if the bowels are sluggish, small enemata should be ordered. The patient should be kept rigidly quiet for at least a month.

Pulmonary Complications.—Although any form of pulmonary disease may at times complicate a surgical procedure, we are here concerned only with those which are of more common occurrence : (1) Hypostatic pneumonia ; (2) Septic pneumonia ; (3) Pulmonary embolism.

1. *Hypostatic Pneumonia* occurs in elderly subjects, especially in those who have any chronic pulmonary or cardiac lesions, such as chronic bronchitis, or a heart hypertrophied from previous circulatory disturbance. It is not due to a bacterial infection, in the first instance at any rate, although it is possible that in the later stages bacteria may reach the clogged and stagnant tissues and terminate matters by producing a microbic inflammation. This form of pneumonia is, in fact, a stasis or congestion of the vessels at the lung bases, with some œdematous effusion into the alveoli, and it occurs among old people who are kept in bed (especially in the supine position after fractures of the femur) so that the free movement of the posterior part of the diaphragm is interfered with.

In many operations upon the upper part of the abdominal cavity a curious pulmonary complication is met with, described by Pasteur as ‘ massive collapse.’ It appears to be an œdema, partly the result of impaired movement of the diaphragm.

In connection with these pulmonary complications we realize the value of the proverb, ‘ Prevention is better than cure ’ ; and in all conditions where they are likely to supervene, special measures must be taken. Elderly patients, the subjects of chronic bronchitis or weak circulations, should never be placed flat on the back in bed, but should be propped up in a semi-sitting posture, which allows the viscera to fall away from the diaphragm. (*See* ‘ Fractures,’ p. 162.)

2. *Septic Pneumonia* is a bacterial infection of the lung, either through the upper air-passages or as the result of pyæmic emboli. As a bacterial infection from above, it usually follows operations on the mouth, such as the removal of the tongue or upper jaw. It is a very dangerous complication, usually fatal, the most favourable ending being a pulmonary abscess.

The importance of care in preparing the mouth as a preliminary in these cases has been alluded to (*see* p. 564), and it is very important, as a preventive measure, that blood should not trickle down the trachea at the time of operation.

A sloughy condition of the mouth after such an operation as removal of the tongue must have the most careful attention. The mouth should be washed out by the patient every hour during the day (carbolic 1–100, or listerine 3 oz. to the pint) ; every two hours a

nurse should gently wipe the surface with a soft Turkey sponge, so as to remove adherent clot.

Morning and evening the house surgeon should make a thorough inspection of the mouth, removing sloughs and dead particles with care, because the sudden detachment of a slough is often followed by secondary hæmorrhage.

It is only by such attention to detail that septic pneumonia can be prevented. The bronchitis kettle, at one time placed beside every tongue case, is not necessary unless there be bronchitis, but the patient must be kept warm and protected from draughts.

As a prophylactic measure the patient may be made to inhale some guaiacol carbonate or cyllin inhalant three or four times a day. In any case where the slightest cough is noticed this treatment will be attended with good results. Guaiacol carbonate 1 dr., or cyllin inhalant 2 dr. and tinct. benzoin co. 2 dr., are dropped into an inhaling flask full of boiling water, and the patient sits up and breathes in the medicated steam.

When septic pneumonia has developed, no special treatment can be adopted. The strength must be maintained by salines and stimulants, and if later an abscess becomes localized it may be opened and drained.

3. *Pulmonary Embolism* has been already alluded to. For the urgent dyspnœa which attends its onset, inhalations of oxygen and artificial respiration should be employed. Injections of strychnine are of service to tide over the period of immediate cardiac failure. Even in cases when sudden death occurs, artificial respiration should be tried.

Rigors and Suppression of Urine.—Suppression of urine rarely occurs apart from renal disease, and has been dealt with. Rigors are a series of shivering fits which are often the prelude to the more serious complication—suppression.

When a rigor follows any operation on the genito-urinary tract, special care must be taken to keep the patient warm, to supply him with warm diluent and diuretic drinks, and he should be given tinct. opii 10 min., quin. sulph. 5 gr. immediately, to be repeated in six hours. Such treatment may avert suppression ; but should it occur it should be treated as previously suggested.

Poisoning from Antiseptics is of very much rarer occurrence than formerly, though it does occasionally arise from absorption of drugs used in the lotions or dressings. The house surgeon should remember the possibility of this occurring, and be able to recognize the early symptoms. Perchloride of mercury, carbolic acid, and iodoform are the three antiseptics most liable to be followed by toxic effects, and a brief account of the most common symptoms will be here given. The signs are often vague, and a certain diagnosis may be impossible, but in any case of doubt the method of dressing should at once be altered.

Perchloride of Mercury.—Poisoning most frequently occurs after large irregular cavities have been washed out with a strong lotion, some of which is retained and absorbed. The chief symptom is diarrhœa with abdominal pain and distention, and blood may also be passed per rectum. Salivation is rarc. Suppression of urine is common. There may be at first some rise of temperature. Death occurs either from collapse or the exhausting effect of the diarrhœa, or the effects of suppression. Post mortem, inflammation and ulceration of the intestines will be found, usually most marked in the large gut.

Carbolic Acid.—Under the old Listerian method of dressing, it was not unusual for the urine, yellow when first passed, to become of an olive-green colour on standing ; or it might be tinged when first passed, the colour deepening afterwards until it became almost black. This condition by itself is not of any great importance, but when poisoning occurs there are various symptoms added, of which severe vomiting is the most important. The temperature usually becomes subnormal, and a condition of collapse supervenes, with a rapid feeble pulse, fixed pupils, and muscular twitchings, ending in death. The sulphates also disappear from the urine, and albumin may be present. Some persons appear to be particularly susceptible to carbolic acid, and show symptoms of poisoning when only small quantities have been absorbed.

In carbolic acid poisoning the frequent administration of small doses of sulphate of soda has been recommended, and should be tried.

Iodoform poisoning is rarely seen in England, where the drug is used in much smaller quantities than abroad. The symptoms are very variable, and the diagnosis is often difficult. In some cases there is simply collapse, in others a high temperature. The pulse is frequent and feeble, and there may be wild delirium, or drowsiness, especially in children. The patient rapidly emaciates, there is loss of appetite, and he complains that everything smells and tastes of the drug.

Treatment.—In all cases of poisoning, the first and most obvious treatment is to discontinue the use of the toxic drug, and the wound should be thoroughly cleansed with a non-poisonous lotion, such as boric acid. Saline purges should be administered, and saline infusion practised if the case demands it.

SPECIAL COMPLICATIONS OCCURRING DURING AFTER-TREATMENT.

Shock and hæmorrhage, which may attend any surgical proceeding of importance, have been duly considered ; for the present only those complications which are of common occurrence will be discussed.

Vomiting is a common complication, and there are few abdominal cases in which it will fail to occur ; but at the outset it is necessary to recognize that there are four distinct varieties : (1) Post-anæsthetic ; (2) Gastric and nervous, occasionally renal or uræmic ; (3) Peritonitic ; (4) Obstructive.

1. *Post-anæsthetic Vomiting* is largely due to the excretion of the anæsthetic by the gastric mucous membrane. In the majority of cases it is slight and soon passes off, and the chief difficulty attending the satisfactory treatment of some post-operative complications which give rise to vomiting, such as regurgitant vomiting after gastro-enterostomy, or that due to intestinal obstruction, is the fact that it is often impossible to discriminate, at any rate at first, between post-anæsthetic sickness, and sickness due to some serious disturbance. As a preventive measure before operation, in addition to the administration of glucose, the hypodermic injection of morph. sulph. $\frac{1}{5}$ gr., atrop. sulph. $\frac{1}{100}$ gr., is of undoubted value, and it is said that the administration of 4 to 6 oz. of plain water just before the anæsthetic is begun has the effect of diluting the drug as it reaches the stomach. Unless the duration of this symptom is protracted—when its consideration falls under the second heading—no treatment is required beyond stopping all feeding by the mouth for six to twelve hours.

2. *Gastric and Nervous Vomiting.*—Unfortunately, cases are now and then encountered where vomiting is a very serious and distressing complication, continuing for days, and apparently little influenced by drugs ; indeed, a fatal issue may result from this alone. Instead of the sickness gradually ceasing, as it should do about the second day, it persists, to the extreme discomfort of the patient and the anxiety of the surgeon. Such vomiting may follow operations on other parts of the body than the abdomen, and it is by no means clear whether it is the effect of the anæsthetic upon the stomach or nervous system, or whether it results from some other obscure nervous change.

Treatment should be directed along two definite lines. If the vomited matter contains a large quantity of bile, the stomach is probably in an unhealthy state ; there is a certain amount of gastritis, and no good results from the use of gastric sedatives.

The first and most important step is to get the stomach clean. This can be done by giving the patient a tumbler (half a pint) of warm water with a dessertspoonful of bicarbonate of soda dissolved in it. Such a draught provokes prompt emesis, and enables the patient to get rid of a quantity of mucus and bile which are clinging to the walls of the stomach and irritating them.

A weak solution of iodine, 10 to 20 min. of the tincture to the half-pint, may be used instead. This treatment has been found most effective in cases where the ordinary remedies had entirely failed.

If this draught is retained and prompt emesis is not provoked, the stomach must be washed out with warm bicarbonate of soda solution, a teaspoonful to the pint, or warm saline. It is an unpleasant procedure, but of the greatest benefit, and it should not be shirked because of the temporary discomfort to the patient.

Such treatment has given surprisingly successful results in cases of persistent vomiting after gastro-enterostomy and in cases of uræmic

sickness. But when it is obvious that there is no accumulation in the stomach, or when, in spite of the above treatment, vomiting persists, we must endeavour to check it by means of drugs.

It can be said at once that no one drug will effect a cure in these cases ; it is often necessary to make a trial of a large number before one is found that has a good effect in a particular case, and indeed in some instances the sickness seems gradually to wear itself out uninfluenced by drugs.

First try small repeated doses of cocaine and peppermint :—

℞	Cocaine Hydrochlor.	gr. $\frac{1}{20}$	Aq. Menth. Pip.	ad ℥ss
	Tinct. Card. Co.	♏xv		

To be given every hour up to four doses.

Next try hydrocyanic acid or bismuth :—

℞	Bismuth. Subcarb.	gr. xx	Sp. Chlorof.	♏xv
	Sod. Bicarb.	gr. xv	Aq. Menth. Pip.	ad ℥j

4tis horis.

℞	Sod. Citrat.	gr. xxx	Sp. Chlorof.	♏x
	Sod. Bicarb.	gr. xx	Tinct. Card. Co.	ʒj
	Acid. Hydrocyan. Dil	♏iij	Aq. Menth. Pip.	℥j
	Sp. Ammon. Arom.	♏xx		

4tis horis.

If these fail, chloretone 5 gr. every three hours up to 20 gr., or ammonium bromide 15 to 20 gr., may be tried. Should none of these drugs have any effect, apply a mustard plaster, 4 in. square, to the epigastric region.

As already pointed out, failure will often follow treatment, and two points must specially be borne in mind : (1) It is not always necessary to stop all feeding by the mouth in these cases. Sometimes sips of iced champagne or a little solid food—a piece of bread and butter—will be found to succeed when drugs fail ; but if the vomit occurs strictly in relation to food, and if it is very frequent, the patient must be fed rectally. (2) Constant vomiting is not only distressing, but weakening ; therefore saline injections into the bowel must be employed, and if there are great restlessness and exhaustion from disturbed sleep, a small hypodermic injection of morphia should be given.

Warning.—Some patients are susceptible to enemata and morphia, and both may cause an increase of the symptoms ; the condition is, however, rare. I have known patients who have an idiosyncrasy against eggs vomit when on a diet of albumen water.

Uræmic Vomiting is to be treated mainly by saline injections and by washing out the stomach ; the bowels and skin should be made to act freely.

The use of calomel and saline purgatives will be discussed below.

3. *Peritonitic Vomiting.*—Peritonitis, whether present at the time of the operation or resulting from it in a mild or severe form, causes

troublesome sickness, and this is the more to be feared since in such a condition the patient wants all his strength and energy to combat a dangerous disease.

The vomiting is due to two separate conditions : (1) To the irritation of the inflamed peritoneum, the vomiting being reflex and of short duration ; (2) To distention of the intestines and pressure on the stomach, and in the later stages to actual obstruction.

So long as there is no marked distention of the abdomen, treatment on the lines suggested above should be adopted ; but when it is accompanied by distention of the gut, a different and more active line must be attempted (*see* 'Meteorism,' p. 581).

This mainly consists in giving repeated small doses of calomel $\frac{1}{2}$ gr., or magnesium sulphate 1 dr., every hour up to ten doses, with the idea of getting the bowels to act and so diminishing the meteorism. In addition to this, fomentations as hot as can be borne should be placed on the abdomen *over* the gauze dressing. This application is very successful in relieving pain and in checking vomiting.

Peritonitic vomiting is distinguished from the other varieties by the fact that it is accompanied by abdominal rigidity, later by distention and an *increasing pulse-rate.* In the milder varieties of the disease, such as the plastic form which follows any extensive abdominal operation, or in those cases of extensive peritonitis which have been operated upon successfully, the vomiting will gradually subside as the general condition improves.

4. *Obstructive Vomiting.*—An occasional complication following abdominal operations is mechanical obstruction by a band of adhesions, or a kink in the intestine. In the later stages of peritonitis obstruction is present, but it is due to paralysis of the muscular coats of the bowel, and a similar condition may result after an obstruction has been relieved, as in strangulated hernia.

Early recognition of this condition is most difficult, since it is obviously complicated and masked by post-anæsthetic vomiting. The following points may be of assistance : (1) If the post-anæsthetic vomiting has ceased for some time, and the patient subsequently is often sick, this suggests some cause other than the anæsthetic ; (2) If the vomit becomes first bile-stained and then sour—duodenal and jejunal contents (it is not necessary to wait until the vomit is stercoraceous)—obstruction is probably present ; (3) If severe spasmodic abdominal pain is complained of ; (4) If distention comes on in the absence of obvious peritonitis ; (5) If no action of the bowels can be obtained, especially if no flatus is passed ; (6) If the pulse-rate increases, and the general condition of the patient becomes rapidly worse, *organic* obstruction is present, and the abdomen should be opened without delay.

Hiccough or Diaphragmatic Spasm is a complication usually associated with vomiting ; in many cases it is a symptom suggestive

of a spreading peritonitis, but it is met with after operations in which the peritoneum has not been damaged ; it is often a troublesome complication of nephrectomy and prostatectomy.

If hiccough is a symptom of progressive peritonitis, treatment must be directed to this grave condition ; otherwise attention must be given to the state of the stomach or the nervous system. If the stomach is dilated it should be washed out as suggested under 'Vomiting,' after which gastric sedatives and a mustard plaster to the epigastrium should be tried. When, however, hiccough arises as the result of some nerve disturbance—we have seen it in an aggravated form after nephrectomy—the effects of treatment are by no means satisfactory. It is a serious complication if prolonged, and may cause death by exhaustion. If in spite of a severe hiccough a patient is able to get sleep and rest, the prognosis is good ; in such cases the hiccough gradually ceases.

Treatment when gastric trouble is not present :—

1. First try nitroglycerin $\frac{1}{100}$ gr. three or four times a day.
2. Bromide of potassium, 20 gr. ; chloral hydrate, 20 gr. ; aq. chlor. 1 oz. ; for three doses ; by mouth or per rectum.
3. A solution of benzyl benzoate, 20 per cent in alcohol, ♏xx–xl in water or milk.
4. Faradization over phrenic nerve.
5. Hypodermic injection of morphia.
6. In severe cases, anæsthesia must be induced.

Meteorism, or distention of the intestines with gas, may occur in straightforward abdominal cases, when no peritonitis has supervened. If the bowel has been imperfectly cleaned out before the operation, fermentative changes may take place in the large intestine and cause a great deal of trouble. But for the most part meteorism is a complication of peritonitis, and is serious because it prevents the intestine from carrying off its contents ; the distention increases, and total paralysis of the bowel and obstruction result.

Treatment.—Immediately after operation pass a small tube a few inches into the rectum and leave it there. The abdominal muscles are often incapable of exerting any contractile power after an operation, and as such contraction is of assistance in expelling flatus, something must be done to make its passage easy. The position of the patient is, moreover, one which does not readily permit of relaxation of the sphincter ani. In cases where continuous rectal saline is administered, the saline tube has the same effect. If distention comes on shortly after the operation, say within twenty-four to forty-eight hours, give slowly a turpentine enema (*see* 'Enemata,' p. 406). If this is retained, give a glycerin enema. Start calomel by the mouth (*see* above). Give hypodermic injections of strychnine, atropine, or eserine. Eserine, in doses of $\frac{1}{20}$ gr. by mouth, or $\frac{1}{50}$ gr. hypodermically, is of the greatest possible value in treating distention : it is much more active than strychnine. It is often necessary

to work very hard at these cases ; many enemata have to be given before finally the intestine expels its flatus, and it may be necessary to extend their use over several days. It must be borne in mind that the flatus is in both large and small intestine in many cases : it is an easy matter to get an enema into the large, but impossible to introduce it into the small bowel. A certain amount of distention will therefore persist until the bowels act freely from above. It is no use injecting a turpentine enema into the rectum ; it must be introduced into the colon, and the tube must be passed well up into the bowel for this purpose. A turpentine stupe or radiant heat from an electric bulb suspended in a cradle is of the greatest comfort to a patient suffering from meteorism.

In a few cases enemata will fail to effect their object, but let it be made clear once more that some patience and perseverance are needed before giving up the attempt ; in such a case the bowel should be opened and a tube inserted into the cæcum or small intestine. Although a *dernier ressort*, and one which the visiting surgeon will perform if he thinks advisable, it is a method that undoubtedly saves life. A preparation of pituitary extract has frequently been employed for the relief of meteorism ; it is a drug of considerable value in cases of shock also. It must never be used in patients over 50 or in those with advanced arteriosclerosis ; the writer has met with a fatal result from its employment in such a case. The drug is put up in ampoules, and is administered hypodermically.

In severe cases of meteorism such as is seen in the late stages of diffuse peritonitis and intestinal obstruction, especially in those showing signs of toxæmia (anxious expression, earthy complexion, moist cold forehead, cold extremities, purposeless movements, frequent vomiting, and failing pulse), a remedy of proved value, even in desperate cases, is the administration of a large intramuscular injection (80 c.c.) of anti-gas-gangrene serum, after the necessary operative measures have been taken. In some cases a second injection of half the amount is necessary in twenty-four hours. This remedy was introduced following the researches of Mr. B. W. Williams of St. Thomas's Hospital, and, in my experience, has saved cases which seemed hopeless. Not only will some cases show a dramatic improvement, but the healing of the wounds has been much accelerated, and, since using this remedy, I never see those cases of sloughing phagedæna which used to occur from time to time.

CHAPTER LII

ON URINE TESTING

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AN examination of the urine of all new cases should be made, whether disease of the kidneys is suspected or not, and therefore a brief account of the most important tests is here given, with their significance.

The urine of a healthy person is perfectly clear or only very faintly clouded when passed. When allowed to stand, that is to say, to cool down to the temperature of the room, a faint cloud appears, due to mucus. The colour is pale lemon or straw, but the intensity of the colour depends a good deal on the amount of water present, or, to put it in another way, on the specific gravity. The less the water the greater is the proportion of salts, the higher the specific gravity the deeper the colour, and *vice versa*. Any great change from this colour indicates some pathological condition; red or smoky urine shows the presence of blood, a yellowish-green or brown is associated with jaundice, and when carbolic acid is being absorbed the urine becomes black.

The smell of freshly passed urine is well known, the most important departures from the normal being due to turpentine (which gives an odour resembling that of violets), asparagus, and a few other bodies. The ammoniacal smell associated with decomposing urine is readily recognized.

The quantity passed daily by a healthy adult varies from 45 to 65 oz., or 1250 to 1850 c.c., but considerable physiological variations may occur, depending on the amount of liquids consumed, the state of the bowels and skin, the time of year, etc.; the flow during certain portions of the day varies considerably. To estimate the amount, the total quantity for twenty-four hours must be collected and measured.

Increase in the Amount, if persistent to any great degree, indicates some pathological condition in most cases, but allowance must always be made for temporary nervousness, during which very large amounts are often passed. The conditions in which polyuria are found are diabetes mellitus, diabetes insipidus, those in which the blood-pressure becomes raised, for example in arteriosclerosis, after the administration of drugs which act either as direct or indirect diuretics, at the crisis of certain diseases, in chronic interstitial nephritis, and in certain forms of hysteria occurring in males or females.

Decrease in the Normal Amount is associated with the low blood-

pressure seen in some forms of heart disease, and particularly with the low blood-pressure associated with concussion and shock following injuries, or temporary heart failure from other causes. It is also observed in all febrile conditions, owing to the large amount of water-vapour given off by the skin and lungs. In all forms of acute and subacute nephritis there is a very marked diminution. In cases where some obstruction exists preventing the flow of urine down the ureter, such as the pressure of inflammatory exudation, or the presence of a new growth or stone, marked diminution occurs ; also in cases where there is accumulation of fluid in the body, as, for example, in the marked ascites associated with cirrhosis of the liver, tuberculous peritonitis, and other causes.

Suppression of Urine, a condition known as anuria, is very likely to occur in the early stages of an attack of acute nephritis, or from any source of local irritation in the urogenital tract ; thus a direct local cause might be a renal calculus ; an indirect or reflex cause might be a wound of the urethra, or the irritation caused by too forcible attempts to pass a metal catheter through a stricture.

The Specific Gravity of normal urine lies between 1015 and 1025, but if above or below this may possibly be due to physiological variations, and not to disease. To obtain the specific gravity accurately, the whole amount of urine passed in twenty-four hours should be mixed, and a part taken for examination, as it is found that considerable alterations take place during the day, especially if large amounts of fluid are taken at meals or other times.

Reaction.—Normal urine is, as a rule, acid, turning blue litmus paper red ; but on standing for some time it becomes alkaline, owing to the development of bacteria ; it then deposits a sediment composed of ammonium magnesium phosphate $MgNH_4PO_4$, calcium phosphate $Ca_3(PO_4)_2$, and later ammonium urate $C_5H_2(NH_4)_2N_4O_3$, developing a smell of ammonia, not unlike that of a stable.

In the urine several salts are held in solution, the most important being chloride of sodium, sodium and other sulphates, certain phosphates, urates, and also urea, creatinin, etc.

Urea, $CO(NH_2)_2$, is the most important nitrogenous constituent. In febrile diseases the amount excreted is increased, in consequence of the excessive tissue destruction, and this increase is often observed even for some days after the temperature has fallen to normal. A great increase is observed in diabetes mellitus. There is also a great increase in physiological conditions where excessive proteid is being taken in the diet, and in pathological conditions where the patient is on a full diet and marked muscular wasting is resulting. A diminished excretion is observed in association with diseases of the liver, such as acute yellow atrophy, carcinoma, and cirrhosis, and in all forms of Bright's disease.

Urea is recognized under the microscope by its fine white needle-like crystals, when rapidly formed, but when allowed to crystallize slowly

it forms colourless quadratic rhombic prisms. It is important, however, to remember that urea is *never found as a deposit* in urine, owing to its great solubility. To estimate the amount of urea present a ureometer (*Fig.* 325) is used. This consists of a burette (*b*) attached to a reservoir (*c*), capable of being raised or lowered. From the top a tube leads to a bottle (*a*) containing 25 c.c. of a 40 per cent solution of sodium hydrate and 2 c.c. of bromine.

To test a urine, 27 c.c. of the hypobromite solution is placed in the bottle, and 5 c.c. of urine in the small tube. Water is poured into the burette, which must be disconnected from the bottle, so that it appears in the movable limb ; the bottle is then connected and the water brought to a level in the tubes. Then a reading should be taken by the markings. By tipping the bottle the urine is mixed with the hypobromite solution and a certain volume of nitrogen is liberated, the water being driven down in the burette. After waiting some time to allow the gas to cool (considerable heat being produced by the reaction), the pressure is again equalized by lowering the reservoir, and a second reading is taken by the markings. The difference between the two will give the amount of nitrogen liberated from 5 c.c. of urine. The gas liberated is the nitrogen of the urea. In Gerrard's ureometer (*Fig.* 325), the burette is calibrated so that it reads off directly the percentage of urea (in grammes per 100 c.c.). For very accurate determinations various allowances have to be made for barometric pressure, the temperature, and the tension of aqueous vapour ; but for these details the student must refer to larger works. The normal percentage of urea in urine is 2 per cent, and the daily excretion is 30 grm., or about 1 oz.

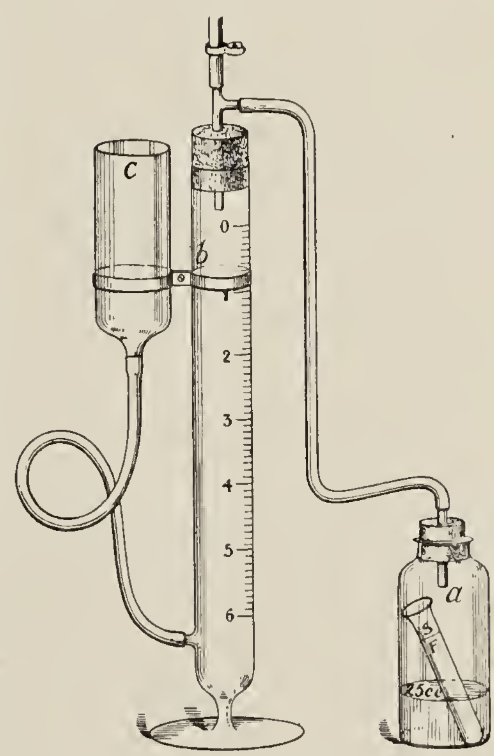


Fig. 325.—Gerrard's Ureometer.

Uric Acid, $C_5H_4N_4O_3$, is present as sodium quadriurate in small quantities in normal urine, being increased in febrile diseases and in persons who suffer from the uric acid diathesis, and by the action of certain drugs. There is an increase in the uric acid excretion in pathological conditions where there is excessive proteid metabolism, e.g., diabetes and other diseases associated with muscular wasting where the patient is on a full diet ; also there is a physiological increase where excessive quantities of proteid are being taken, particularly where excessive amounts of nucleoproteid are being consumed, since this especially leads to the production of uric acid. A pathological example of the latter condition is leucocythæmia, where the uric acid excretion is often doubled. In concentrated

urines the quadriurate of sodium (and potassium and ammonium) separates out when the urine cools, as a red-brick amorphous deposit ; the colour of this deposit is due to urinary pigments carried down with the quadriurates. In urines where there is little pigment, e.g., that of women and children, the quadriurates often form an almost white, or pinkish-white, deposit. Where the urine is very acid, the uric acid is deposited in the form of the free acid and not as the quadriurates. Then the uric acid forms the well-known red deposit which has been likened to the colour of cayenne pepper. This colour is due to the urinary pigment carried down with the uric acid crystals (these being in the pure state colourless). The normal daily excretion of uric acid is about $\frac{1}{2}$ grm.

Its presence may be shown by several tests, the most satisfactory being that known as the murexid. To 200 c.c. of urine add 10 c.c. of hydrochloric acid and set aside for twenty-four hours, filter, dissolve the precipitate in strong nitric acid, evaporate to dryness, and add a drop of ammonia, when a deep purple-red colour will appear. The best method of estimating uric acid is that devised by Hopkins, for details of which see special works on urine analysis.

Oxalic Acid, $C_2H_2O_4$, as the calcium salt, is another constituent of the urine, separating out if the acidity is diminished. The octahedral crystals are easily recognized, and are known as envelope crystals ; sometimes the crystals appear as dumb-bells (*see Plate XV, C*).

Albumin.—It is not intended to enter deeply into the question of the presence of albumin in health ; it will be sufficient to say that it may be present and not justify us in saying that there is any grave organic disease of the kidneys. This condition is known as functional albuminuria ; in it the urea, chlorides, and other constituents of the urine are normal, and no casts are present, while in pathological albuminuria there are always abnormal variations in the other constituents. There are several albumins which may be present in the urine, but serum albumin is the most important clinically, and is the only one referred to here.

Albumin is present in the urine in many diseases, the most important being acute and chronic nephritis, amyloid disease of the kidneys, heart disease, febrile conditions, and after taking certain drugs.

Its presence is recognized by the following tests :—

Boiling Test.—This is much the most reliable test. If the urine is acid, place it in a test tube ; if not acid, make it *slightly acid* by the addition of 2 per cent acetic acid, and then place in the test tube. Boil the upper part of the urine in the tube by heating the upper portion, then notice if a cloud has formed ; now add a few drops more of the acetic acid solution, and if albumin is present there will be a distinct precipitate or cloud in the portion of liquid heated. Occasionally a cloud forms in the upper part of the liquid, due to the deposition of earthy phosphates ; this, however, instantly dissolves on the addition of acetic acid after boiling.

Salicyl-sulphonic acid solution (10 per cent) is a very delicate test for albumin. A few drops of the solution added to urine give a white precipitate if albumin be present ; the precipitate is insoluble on heating.

Nitric Acid Test.—Fill a test tube about a third full of urine, and allow concentrated nitric acid to run slowly down and settle in a layer at the bottom. The presence of albumin is indicated by a cloud forming between the two layers of fluid. It is not a delicate test.

Picric Acid Test.—This is used as a quantitative test, and is known as Esbach's.

The picric acid solution is made as follows : Picric acid 10 grm. ; citric acid 20 grm. ; distilled water 1 litre.

Equal parts of this solution and the urine are mixed in a specially graduated tube, and allowed to stand for twenty-four hours, a stopper being plaeed in the mouth of the tube. At the end of this time the precipitate—which consists of uric acid, creatin, and other bodies, as well as albumin—will have settled down, and the amount of albumin per mille in grammes can be read off by the scale.

Blood may be present in the urine, and may tint it red or dark brown. It is readily recognized by a microscopic examination, the characteristic appearance of the red corpuscles being seen. The spectroscope forms a most reliable method of quickly recognizing the presence of blood. By looking through the urine in a test tube (filtered if necessary), the spectrum of oxyhæmoglobin or possibly of reduced methæmoglobin is observed, and this can be confirmed by gently warming the urine with about 20 drops of caustic potash solution and 5 drops of ammonium sulphide, when the characteristic spectrum of hæmochromogen becomes at once visible.

The chemical test for blood in urine is as follows : Take a test tube about one quarter full of urine, add about 10 drops of fresh tincture of guaiacum, which should be of a light amber colour and not too strong, mix, when a milky liquid results, owing to the deposition of the resin in the tincture of guaiacum. Now pour carefully down the side of the test tube some fresh sensitive ozonic ether. If blood is present, a blue colour will develop almost immediately. It must be remembered that if pus is present, or potassium iodide, then this result may be given in the absence of blood.

Sugar.—Several carbohydrates may be present in the urine, but glucose is the only one of general clinical interest.

It may be present physiologically owing to the excessive consumption of sugar and carbohydrates, that is, its presence does not always indicate disease, though any case in which it is found must be looked on with great suspicion. It also occurs in the urine pathologically in many conditions which are not true diabetes, e.g., in gout, Graves' disease, abdominal tumours, cerebral tumours pressing on the fourth ventricle, etc. This is known as glycosuria. The disease indicated by its presence is diabetes mellitus, and persons suffering from this

complaint and also from glycosuria bear surgical operations badly. The tests employed to show its presence are many, but only three qualitative and two quantitative are given here.

Fehling's Test.—The two solutions employed are best kept apart till required for use. Their composition is as follows :—

1. Crystallized copper sulphate 34·64 grm. dissolved in 500 c.c. of distilled water.
2. Sodium and potassium tartrate, 173 grm. ; potassium hydrate, 125 grm. ; distilled water, 500 c.c.

Equal parts of these two are mixed, brought to the boiling point, a few drops of the urine added, and the mixture well boiled. If sugar is present, a yellow precipitate of suboxide of copper is thrown down. It must be remembered that only the presence of the precipitate indicates that sugar is in solution in the urine, and that a change of colour, such as green, is of no importance. It must be also remembered that sometimes a brownish flocculent precipitate is produced when no sugar is present, owing to the presence of creatinin, uric acid, glycuronic acid, or albuminous bodies.

Where the reaction is not well marked and definite, a confirmatory test should be applied. The following two tests are conclusive :—

a. The Fermentation Test.—Take a test tube, place in it a lump of yeast the size of a nut, fill completely with the urine, place the thumb on the end of test tube, invert, and place the open end of the test tube beneath the surface of some of the urine in a dish, then remove the thumb, when the test tube will be vertical and filled with the urine to be tested and contain the lump of yeast. Now support the tube in this position, and place it with the dish in an incubator or in a warm place. In an hour or so the urine will begin to descend in the tube owing to the production of carbonic acid gas by the fermentation of the sugar in the urine. If no sugar is present, the tube will remain filled up with urine.

b. The Phenyl Hydrazin Test. — Dissolve 1 grm. of phenyl hydrazin hydrochloride and 3 grm. of sodium acetate in 15 c.c. of water, filter, add 5 drops of acetic acid. Now add 5 c.c. of urine, and warm in water-bath for half an hour. Then allow to cool slowly. If sugar is present, a light yellow precipitate is seen ; microscopical examination of this precipitate shows beautiful yellow sheaves of needle-shaped crystals (phenyl glucosazone). This test is very reliable and delicate.

To estimate the amount of sugar present, Fehling's solutions are employed, which are so made that 10 c.c. of the mixed solutions will reduce 0·05 grm. of glucose.

It is best to dilute the urine ten times, as the test is then applied more accurately. Place 10 c.c. of the mixed Fehling's solution in a porcelain dish or glass flask, and continue boiling, adding from a burette the ten-times diluted urine drop by drop. An immediate precipitation of oxide of copper takes place. As long as any blue

colour exists in the Fehling solution, the urine is added. When this has entirely disappeared, read off the amount used. To calculate the percentage amount of sugar present :—

If x = number of c.c. of diluted urine used, the percentage of sugar (grammes per 100 c.c.) $= \frac{0.5 \times 100}{x}$.

Though this method of estimation sounds easy, it is by no means so in practice, for no inconsiderable difficulty will be found in being exactly sure that all the blue colour has disappeared. To make quite certain that all copper has been reduced, a drop or two of the solution may be filtered off, acidulated with acetic acid, and a drop of potassium ferrocyanide added. If some copper still remains, a brown coloration appears, showing that more urine should be added. It is of course possible that too much may have been added, so it is as well to repeat the test.

Another method of estimating the amount of sugar present is by fermentation. The specific gravity of the urine is taken accurately, and a small quantity of yeast added, the vessel being placed in an incubator at 37° C. After twelve hours the specific gravity is again taken, and the difference between the two readings, multiplied by 230 (an empirical factor), will give the percentage of sugar present; e.g., if 1·030 and 1·010 are the respective specific gravities, the percentage of sugar = 0·02 × 230 = 4·6 per cent. This method is only approximate.

In the condition of glycosuria apart from diabetes mellitus, if much sugar is present, the patient would be a bad subject for a surgical operation. By appropriate diet and medical treatment, including the hypodermic administration of insulin, the sugar in this condition can usually be rapidly reduced, and then an operation could be safely performed. In true diabetes mellitus there would always be a risk from a surgical operation, especially if a general anæsthetic were given, but this risk may be obviated by suitable medical treatment, such as special dieting and the administration of insulin in severe cases, when the glycosuria will disappear and the blood-sugar become normal. In this stage operative treatment can be undertaken and an anæsthetic given. The urine in this disease is usually very pale, and greatly increased in quantity. In simple glycosuria the quantity is not increased and the urine is normal in colour. In diabetes mellitus the urine usually contains, in addition to sugar, acetone, diacetic acid, and oxybutyric acid. The two former of these can be readily detected, and their presence gives a valuable confirmation of the diagnosis of diabetes. These tests should always be applied whenever sugar is found in the urine. They are as follows :—

Acetone.—Take a test tube one-quarter full of urine, add about 1 c.c. of a 5 per cent solution of sodium nitroprusside, mix, pour some strong ammonia solution (s.g. 0·880) very carefully down the side of the slanted tube, and allow to stand for five minutes. A beautiful rose-violet colour develops at the junction of the two liquids.

Diacetic Acid.—Take a test tube one-quarter full of urine, and add about half the quantity or a little more of ferric chloride solution ; a slight or deep claret colour is produced, according to the quantity of the acid present. If the liquid is well boiled for a few minutes, the colour disappears. (Ferric chloride gives colours with salicylic acid, antipyrin, and carbolic acid, which may be present if being given in medicines ; these colours are not destroyed by boiling.)

Bile Pigments never occur in health in the urine, and are generally associated with jaundice. Their presence is shown by Gmelin's test—a piece of blotting-paper is wetted with urine, and a drop of concentrated nitric acid added. A rainbow ring of colours will form if bile pigments be present. A better test for bile pigments is the 'iodine test.' It is performed thus : Dilute some tincture of iodine with alcohol until it is light red-brown in colour. Place the urine in a test tube, and pour the iodine solution carefully down the side of the slanted tube. Allow the tube to stand for two or three minutes. A green zone forms at the junction of the two liquids.

Pus may be present in the urine, and if in small quantities it can be recognized only by the microscope. If present in any considerable amount, it forms on standing a light-coloured layer which is readily diffused on shaking. It is not soluble in acetic acid, which differentiates it from phosphates, and the addition of caustic potash solution converts it into a gelatinous mass.

Another chemical test for pus is the following : Take some of the deposit by means of a pipette, and place in a test tube. Add fresh ozonic ether or hydrogen peroxide solution. A brisk effervescence of oxygen soon occurs if pus is present.

There are many other bodies found in health or disease in the urine, but for these the student is referred to works on the urine or manuals of clinical diagnosis.

Microscopic Examination of the urine is of great importance, and should never be omitted if there be any sediment. The centrifugal machine may be used to separate the deposits quickly.

The most commonly observed bodies that form deposits in urine are as follows :—

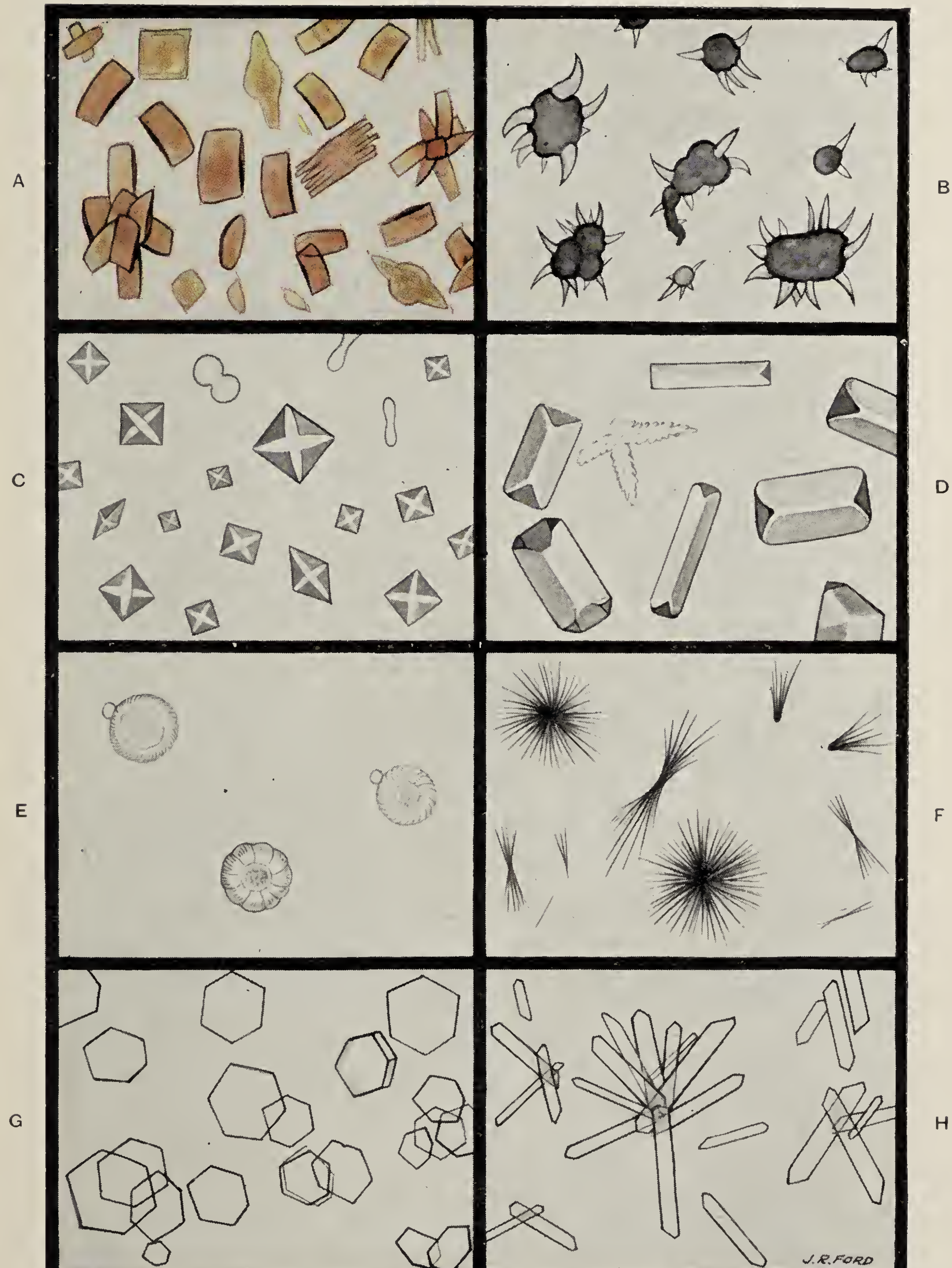
1. *Uric Acid* may appear in several forms, the most common being those shown in *Plate XV, A.* Frequently it separates in large rosettes of crystals of a deep red colour, rhombic prisms—the well-known cayenne-pepper deposit. The test for uric acid has been already mentioned. This deposit occurs only in acid urines.

2. *Amorphous Urates* are commonly seen in the urine of febrile cases, and redissolve on the application of heat. Deposits of urates only occur in acid urines ; they are usually reddish in colour, and form the characteristic brick-red deposit.

3. *Calcium Oxalate* occurs in small, colourless, highly refracting octahedra (*Plate XV, C*), not unlike envelopes. It may also appear in dumb-bell-shaped masses. They are not unlike those of ammonium

PLATE XV

MICROSCOPIC CHARACTERS OF URINARY DEPOSITS: CRYSTALLINE



A, Uric acid. B, Ammonium urate. C, Calcium oxalate. D, Ammonio-magnesium phosphate. E, Leucin. F, Tyrosin. G, Cystin. H, Stellar phosphates.

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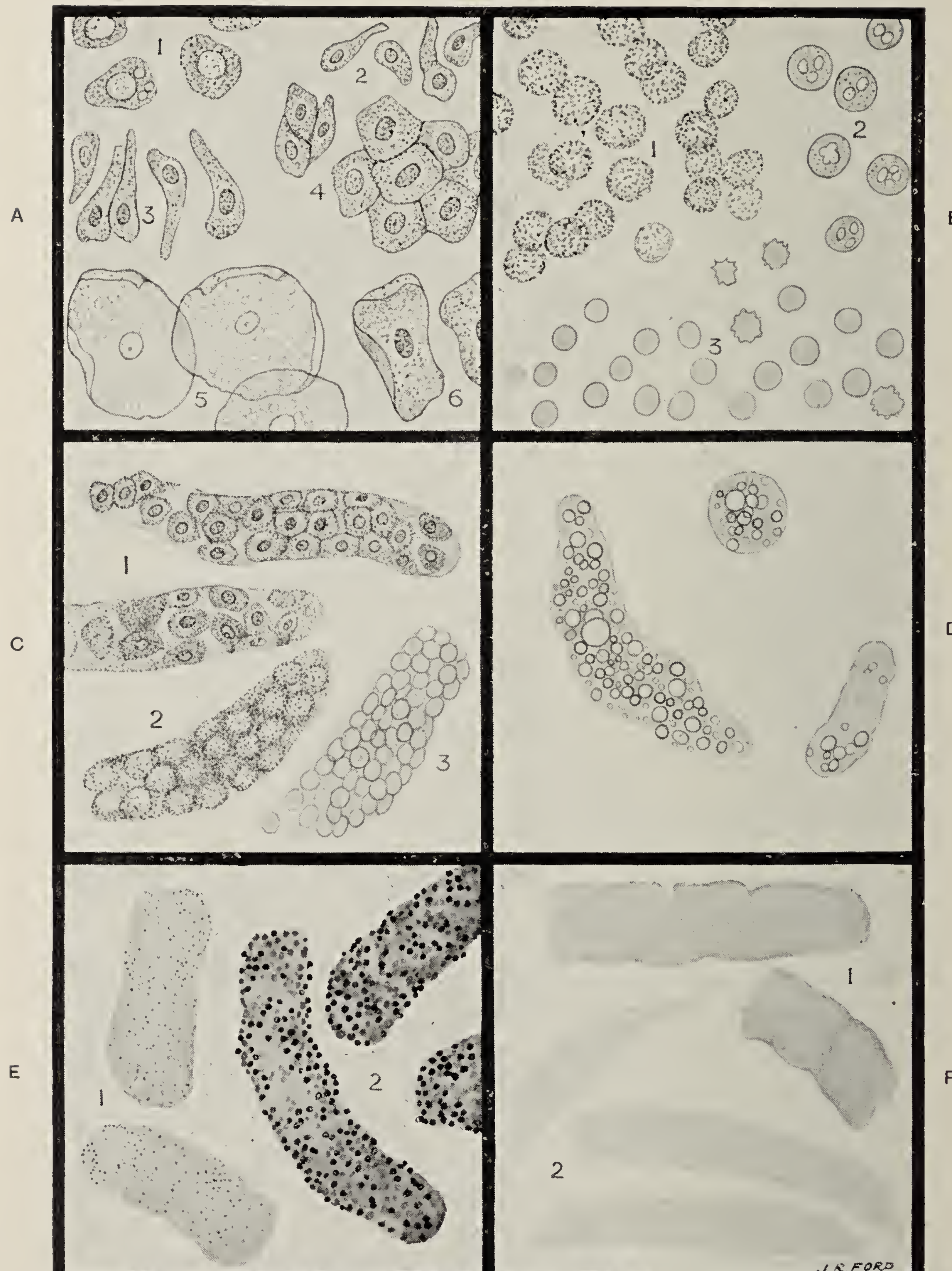
PLATE XVI

MICROSCOPIC CHARACTERS OF URINARY DEPOSITS: ORGANIZED



A, Epithelium from: (1) Renal tubules; (2) Bladder (deep); (3) Renal pelvis; (4) Bladder (superficial): (5) Vagina; (6) Urethra. B, (1) Pus corpuscles; (2) The same treated with acetic acid; (3) Red blood corpuscles. C, Casts: (1) Epithelial; (2) Pus corpuscles: (3) Blood. D, Casts: Fatty. E, Casts: (1) Finely grandular; (2) Coarsely grandular. F, Casts: (1) Waxy; (2) Hyaline.

magnesium phosphate, which are, however, larger, and soluble in acetic acid, while the oxalate ones are not. Calcium oxalate crystals are only found as a rule in acid urines.

4. *Ammonium Magnesium Phosphate*, or triple phosphate, appears as large prismatic rhombic crystals (*Plate XV, D*), which are numerous in alkaline urine.

5. *Calcium Phosphate* is seen in the form of colourless star-shaped crystals (stellar phosphate—*Plate XV, H*), soluble in acetic acid.

Urate of Soda and *Ammonium* (*Plate XV, B*), *Leucin* (*Plate XV, E*), *Tyrosin* (*Plate XV, F*), and *Cystin* (*Plate XV, G*) are occasionally found.

Epithelial Cells (*Plate XVI, A*) are frequent constituents of urinary deposits, and their recognition is of considerable importance in some cases. Three kinds are observed : round, conical, and flat cells.

The round cells are derived from the uriniferous tubules and deep layers of the mucous membrane of the kidneys. They have a nucleus, and by this can be distinguished from pus cells, whose nucleus is only brought out by the addition of acetic acid. Their presence, when associated with albumin and tube casts, generally indicates the existence of pyelitis.

The conical cells come from the superficial layers of the pelvis of the kidney, and also occur in pyelitis.

Flat cells are shed from the bladder and vagina, and are readily recognized.

Leucocytes or Pus Cells (*Plate XVI, B*), of course, show inflammatory changes in the urinary tract, but in women care must be taken to exclude the possibility of some vaginal discharge being mixed with the urine. Their appearance varies considerably ; in acid urines they are little changed from those seen from other parts, but in alkaline urines they are swollen and opaque. Acetic acid brings out their nucleus.

Red Blood Corpuscles (*Plate XVI, B*) are frequently observed in the urine, but the colour produced by them must be distinguished from that produced by the condition known as hæmoglobinuria, in which the red colouring matter of the blood has been removed from the corpuscles and is free in solution.

The colour of the urine will not be altered materially if only a small quantity of red corpuscles are present, so that it may be impossible to determine their presence except by the use of the microscope. The corpuscles will in many cases be found to have been considerably changed in appearance, depending on the length of time they have been in the urine, and other reasons. They may be swollen, crenated, almost colourless, or shrunken, and without their biconcave appearance, so that considerable care must be taken in observing them. Blood casts or tube casts containing blood corpuscles may be seen in cases of hæmaturia of renal origin.

Urine containing blood is always albuminous, due either wholly or

partially to the blood. In nephritis, where blood is present, usually there will be a very large quantity of albumin relatively to the blood, e.g., the urine may become solid or nearly solid on boiling, and yet be only light red or brown in colour from the small amount of blood. Where the blood comes from a traumatic lesion, or from a calculus wounding the kidney or ureter, the amount of albumin present will be relatively much less than with acute or subacute nephritis ; thus there will be only a small precipitate on boiling.

Tube Casts (*Plate XVI, C, D, E, F*) may be present in urinary sediments. They come from the uriniferous tubules of the kidney, and may be clear (hyaline), granular, epithelial, blood, or pus. All these varieties may occur in different conditions, and though their presence always indicates some pathological condition, their full significance is often hard to explain. The student is referred to larger works for greater detail.

Micro-organisms.—It is probable that urine in the bladder of a healthy person contains no micro-organisms, but it is certain that when it has been exposed to the air for a short time they can easily be found.

The variety most commonly appearing is the *Micrococcus ureæ*, to which the ammoniacal fermentation is due. In certain pathological conditions many others may be present, such as the *Staphylococcus pyogenes aureus* and *albus*, the typhoid bacillus, tubercle bacillus, *Bacillus coli communis*, *Diplococcus pneumoniæ*, *Gonococcus*, etc., depending on the particular disease the patient may be suffering from. Their presence is of great importance clinically, especially so in the case of the tubercle bacillus, for the discovery of this micro-organism in the urine may be of great assistance in determining the state of the kidneys and bladder.

CHAPTER LIII

X RAYS: THEIR USES IN DIAGNOSIS AND TREATMENT

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IN the short space that can be given to this subject, it will be impossible to do more than touch briefly upon the more important points in connection with practical X-ray work. For the student who wishes to obtain a more thorough knowledge of the subject, numerous excellent text-books are now available.

The X rays, discovered by Professor Röntgen in 1895, were called 'X' by him because their nature was not fully understood. It is now fairly generally known that these rays have the property, among others, of being able to penetrate the tissues to a greater or lesser degree, according to their density; they also have a photochemical action on photographic plates. It is on these properties that their value as an aid to diagnosis depends. For instance, the bones, being denser than the surrounding tissues, are penetrated to a less extent by the rays; consequently they cast a shadow and so can be seen. The heart is much denser than the lungs, and the shadow of this organ can be clearly seen. An aneurysm of the thoracic aorta can be seen for the same reason, but an aneurysm of the abdominal aorta cannot, unless the walls be calcified as a result of arteriosclerosis, the reason being that the sac of an aneurysm in this region has a density about equal to the other abdominal contents.

It is necessary, therefore, in regions such as the abdomen, where the various organs are of a very similar density, to render opaque artificially those which it is required to examine. In the case of the alimentary tract, this can be done by giving the well-known opaque or barium meal. The gall-bladder can be visualized by giving, by the mouth or intravenously, tetraiodophenolphthalein. The ureters, calices of the kidneys, bladder, and urethra can be rendered visible by the injection of sodium iodide solution; the track of a sinus by injecting it with lipiodol, etc. Lipiodol is an iodized vegetable oil, obtained by fixation of iodine in poppy-seed oil. It contains 40 per cent by weight of pure iodine, and it is this high iodine content that renders it so very opaque to the X rays. This substance has entirely superseded the old bismuth paste injections, and its use has opened up a wide field of radiological diagnosis, since it can be injected with safety into the subarachnoid and epidural spaces, bronchial tubes, uterus and Fallopian tubes, male urethra, etc.

APPARATUS FOR PRODUCTION OF X RAYS.

For the production of X rays, a current of electricity of high potential is required, and certain special apparatus is necessary to produce this current : (1) A source of electrical energy ; (2) A means of converting this energy into a unidirectional one of high potential, and of controlling it.

1. **Source of Electrical Energy.**—This should be, if possible, the mains which supply the house or hospital ; but if there is no electric station in the neighbourhood, it will be necessary to install a gas or oil engine and dynamo.

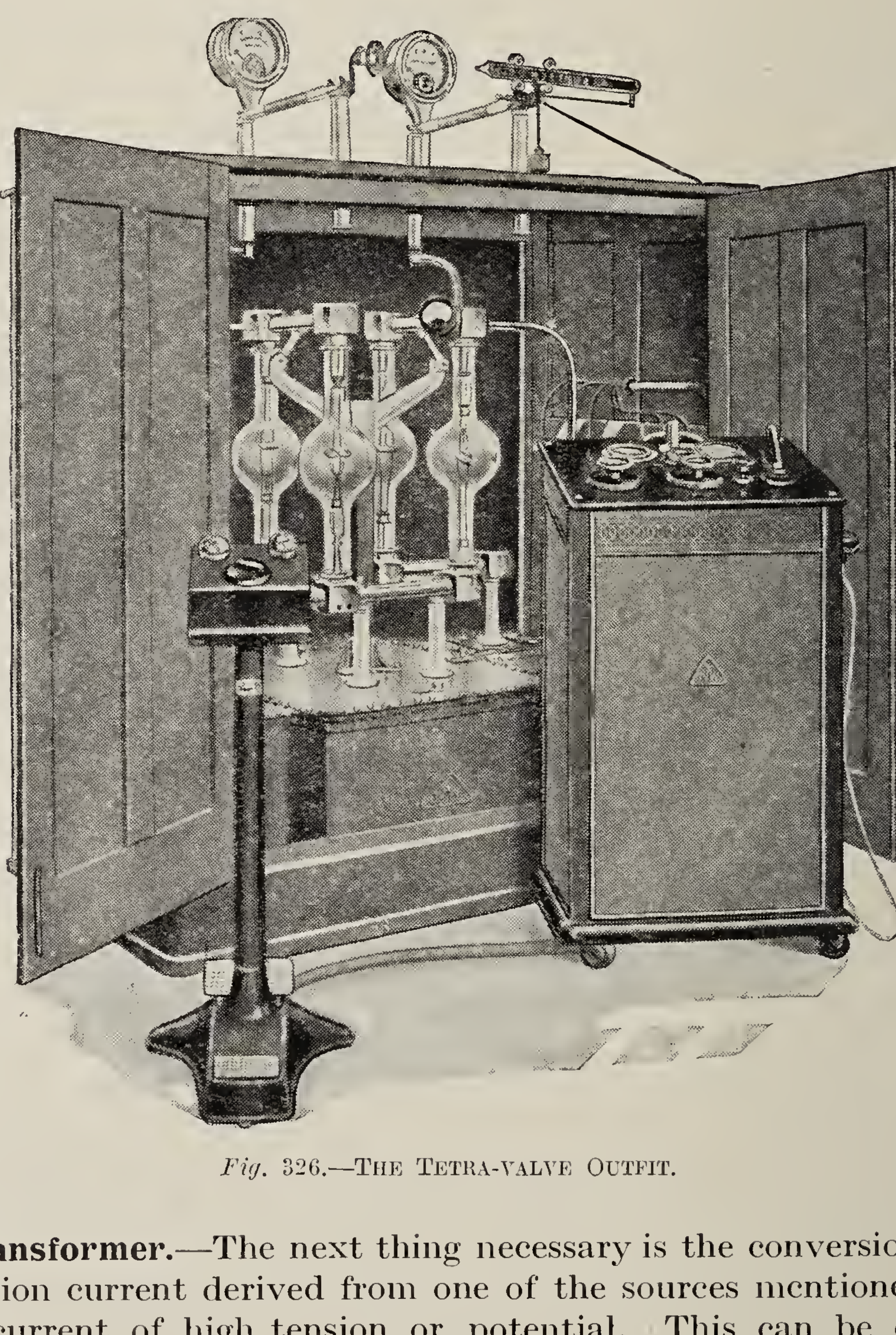


Fig. 326.—The Tetra-valve Outfit.

2. **Transformer.**—The next thing necessary is the conversion of the low-tension current derived from one of the sources mentioned in (1) into a current of high tension or potential. This can be done by means of a high-tension transformer or a large induction coil. Of these, the high-tension transformer in conjunction with the hot cathode tube is rapidly gaining ground, and since the last edition of

this book has almost completely superseded the coil, so that this is the only method which need be touched upon.

If alternating current is available the transformer may be worked directly from the mains, but in the case of direct current it will be necessary to install a motor converter, which of course adds to the expense.

There are several types of X-ray units on the market, the current from which may be non-rectified, as in the single-valve unit, or rectified either mechanically or by hot cathode valves. The latter form of rectification in powerful units is rapidly superseding the mechanical, one of the chief advantages being the absence of moving parts which create noise (*Fig.* 326).

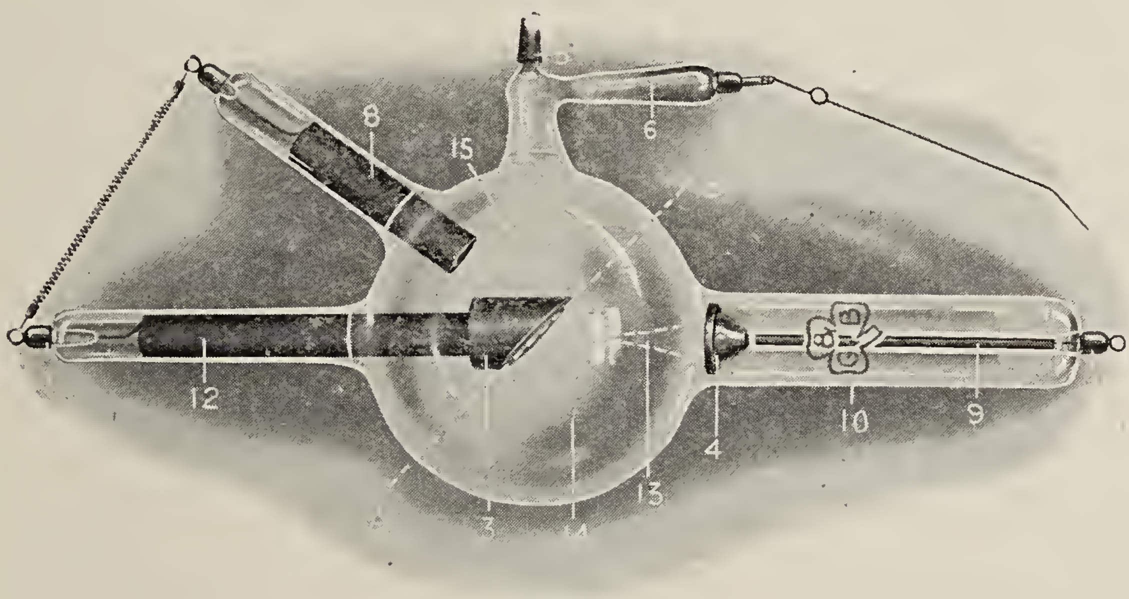


Fig. 327.—X-ray Gas Tube.

1, Positive pole of tube ; 2, Negative pole or cathode ; 3, Anticathode or target ; 4, Cathode (concave cup causing cathode rays to 'focus' on anticathode) ; 5, Exhaust pip (sometimes placed on the bulb and sometimes on the cathode neck 10) ; 6, Regulator ; 7, Regulator wire or arm ; 8, Anode or proper positive pole—anticathode is used as anode as well, making the tube bi-anodal ; 9, Cathode stem ; 10, Cathode neck ; 12, Anticathode stem ; 13, Cathode rays (invisible when vacuum of the tube is correct, but visible as a blue stream when tube is too low, i.e., too 'soft') ; 14, Fluorescent or luminous hemisphere ; 15, Dark hemisphere. A–B, Plane of division between X-ray and dark hemisphere.

The choice of the type of transformer will, of course, vary with the purpose for which it is required and the current available, so that it will be well for the practitioner to consult a reliable firm of instrument makers, stating his requirements.

In addition to the transformer, the further apparatus necessary will be : (3) X-ray tubes ; (4) Instruments for gauging the quantity and quality of the rays ; (5) Apparatus for enclosing and holding the tube in a manner suitable for making an examination ; (6) A fluorescent screen ; (7) Protective apparatus ; (8) A photographic dark-room, X-ray films, and the necessary tanks and chemicals for developing them ; (9) A suitable place for storing the developed negatives.

3. **X-ray Tubes.**—There are two distinct types of X-ray tube at present in use : (i) The so-called gas tube ; (ii) The hot cathode tube.

i. *The Gas Tube* is still used in this country, though its days are undoubtedly numbered. It consists of a bulb of glass very highly exhausted (one-millionth of an atmosphere), a small amount of residual gas being necessary for the supply of electrons. It is provided with two or three electrodes ; of these only two are important, named respectively the cathode and the anticathode ; the third is absent in some tubes, and its function when present is to render the action of the tube more steady. It is often referred to as the anode, and tubes supplied with it are frequently called bi-anodal tubes (*Fig.* 327). At first sight this appears to be confusing, but it must be remembered that the words 'anode' and 'anticathode' are interchangeable terms for the same thing. The so-called anode, when present, is connected to the anticathode by a wire (*Fig.* 327), and we need not consider it further. The cathode is cup-shaped, and made of aluminium because of the power this metal has of resisting disintegration. The anticathode is situated near the centre of the tube, with the surface facing the cathode inclined at an angle of 45°, with an imaginary line connecting its centre with the centre of the cathode cup. The function

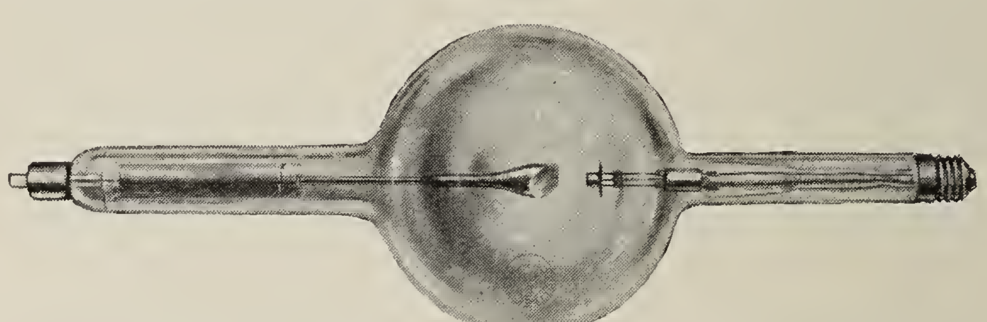


Fig. 328.—Coolidge Tube.

of the anticathode is to arrest the stream of electrified particles (electrons) known as the cathodal stream, which is focused just in front of the anticathode. From the point on the anticathode (*Fig.* 327, 3) where the cathodal stream (*Fig.* 327, 13) is arrested the rays are given off. At this point, too, considerable heat is generated, so that the anticathode is generally faced with platinum, or better still with tungsten ; the latter is much less liable to pit with the heat of the cathodal bombardment, and the best modern X-ray tubes are provided with a tungsten target embedded in a solid block of copper, so that the heat generated is more rapidly conducted away. It is on account of this heating effect that the cathode stream is brought to focus rather in front of the anticathode and is not focused accurately upon it.

The vacuum of a gas tube, although high, tends to become higher with use, provided the tube is not overheated. Hence all are provided with some means of lowering the vacuum when necessary (*Fig.* 327, 6). This does not apply to the hot cathode tube, a short description of which follows.

ii. *The Hot Cathode Tube*, of which the 'Coolidge' was the original (*Fig.* 328), is, comparatively speaking, a new type, and one in which

the vacuum is so nearly perfect that practically all the residual gas is removed by a very complete method of exhaustion. It is impossible to pass a discharge through a tube such as this in the usual manner, because the number of molecules of residual gas is too small. A special cathode is therefore employed, which is made of a spiral of tungsten wire which can be heated, the reason for this being that a metal when heated emits negative electrons, which are identical with those which constitute the cathode stream in the gas tube just described. Now since the quantity of these negative electrons varies with the temperature of the spiral, it is evident, provided the potential remains constant, that by increasing or decreasing the temperature of the spiral we are able to control the quantity of X rays emitted, and, by altering the potential, the quality also. Since the heat of the spiral is easily controlled by a current derived from accumulators, or

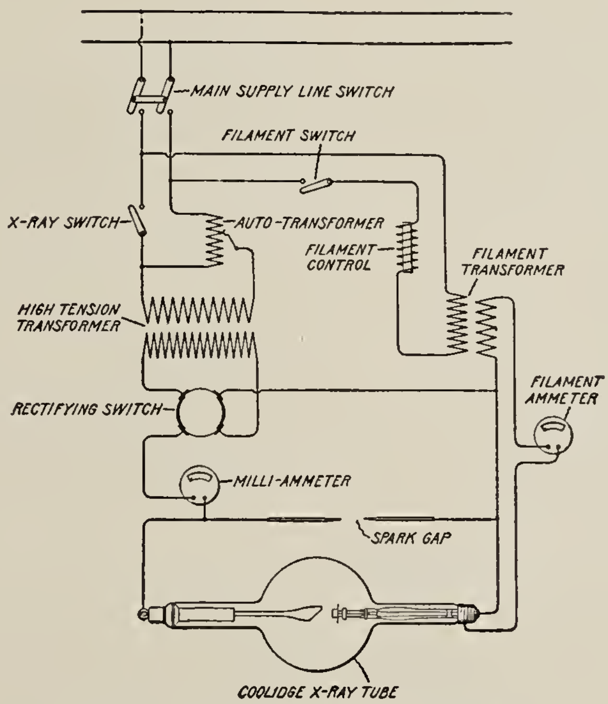


Fig. 329.—Coolidge Tube Scheme.

one of the transformers specially constructed for the purpose (*Fig.* 329), such a tube is under very much better control and possesses very many advantages over the gas tube, more especially since the line focus has been adopted, which gives definition equal to any gas tube. In small installations, however, the initial cost is a great consideration. These tubes cost as much as £40 each, and those for deep therapy (200,000 volts) as much as £80 each or more. On the other hand, if carefully used, their life is very much longer than that of the gas tubes.

Owing to the fact that in the 'Coolidge' type of hot cathode tube X-radiation is emitted from points other than the focus, very efficient protection is necessary, and it should be completely enclosed in a protective box. There has been produced in recent years, however, a new type of hot cathode tube, known as the 'Philips Metalix' tube.

This tube is a departure from the orthodox design, the spherical glass bulb being replaced by a glass cylinder, which is enclosed in a steel tube lined with lead, and so carries its own protection (*Figs.* 330, 331).

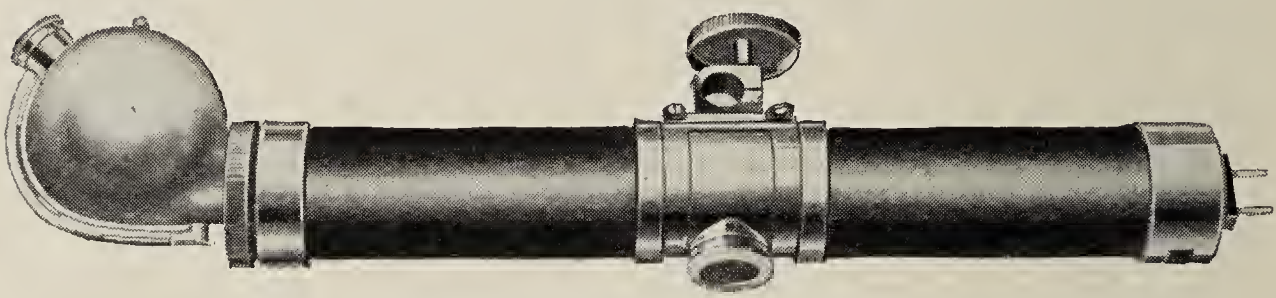


Fig. 330.—PHILIPS METALIX TUBE.

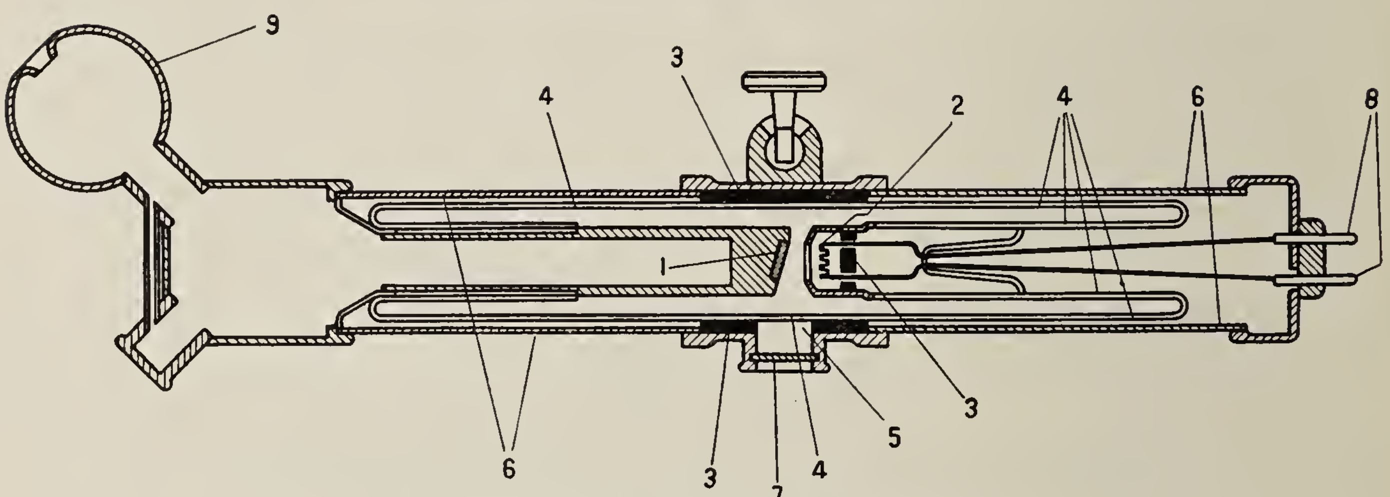


Fig. 331.—SECTION OF PHILIPS METALIX TUBE.

1, Tungsten anticathode.
2, Hot wire cathode.
3, Chrome steel with lead protection.
4, Glass walls of tube.
5, Opening in lead jacket for primary X rays.
6, Insulation cover over tube.
7, Filter.
8, Plug for heating current.
9, Water container.

(*By permission from Schall's 'X Rays: their Origin, Dosage, and Practical Application.'*)

4. **Instruments for Gauging the Quantity and Quality of the Rays.**—The amount of current which passes through the X-ray tube is small, and is measured, not in ampères, but in milliampères. It is essential to know the number of milliampères in use, as on this the quantity of X rays depends. It is necessary, therefore, to install a specially constructed milliampèremeter, which should have a large scale readily readable at some distance. A good model is that illustrated (*Fig.* 332).

In addition to knowing the milliampèrage of the current passing through the tube, it is necessary to know the voltage also, as on the voltage applied across the tube the quality of the radiation depends, the voltage determining the wave-length. The shorter the wave-length, the higher the voltage, the greater the penetrating power of the rays, and vice versa. Now this voltage is extremely high, and is measured, not in volts, but in kilovolts (1000 volts) : 40 to 120 kilovolts are used in radiography, and up to 200 kilovolts or more in radiotherapy. Many ingenious instruments have been devised for this purpose, but the only two that have survived are the sphere gap and the kilovoltmeter.

When a gas tube is employed, the *sphere gap* (*Fig.* 333) is used, and the principles of its action are as follows : The vacuum of a gas tube, as has been stated previously, tends to become higher and higher with use, and as the vacuum becomes higher the resistance increases, the rays become more penetrating, and the tube is said to become harder. If the reverse takes place, as when the tube is overheated or the regulator is brought into play, it is said to become softer. Hence the terms hard, medium, or soft tubes. Since the hardness or softness of a tube depends upon the resistance of the tube, or in other words the voltage necessary to force the current through it, it will be evident that a measure of this resistance will give us a fair idea of the character of the X-ray output. Now the sphere gap can be adjusted to any length, and is so arranged that the current can be passed across the gap or through the

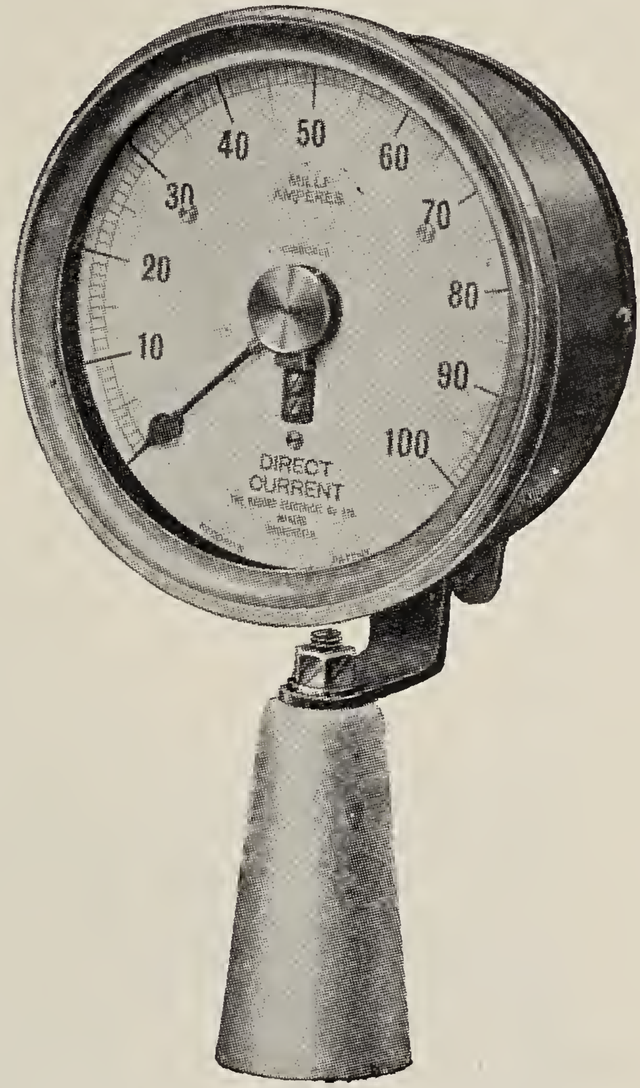


Fig. 332.—MILLIAMPÈREMETER.

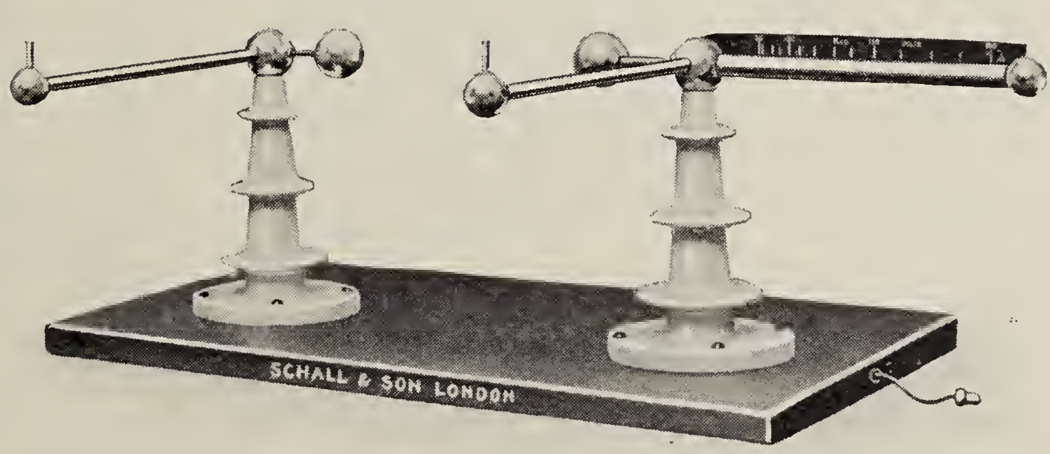


Fig. 333.—SPHERE GAP KILOVOLTMETER.

Consists of two porcelain columns mounted on a dark oak board. One aluminium sphere is permanently fixed to one column. The other is attached to a rod moving in and out of a tube on the other column. The gap can be narrowed by pulling a cord which is led down through the right-hand column. When the cord is not pulled, a spring pushes the right-hand sphere back so that the gap is always at its maximum length—to prevent unnecessary sparks. A pointer and scale show the kilovoltage for any position of the two spheres.

tube. The current will take the path of least resistance, so that if the resistance of the tube is greater than that of the gap, it will

pass across the gap and not through the tube. We therefore separate the spheres of the gap until the current just ceases to pass across it, and passes through the tube instead. This distance can be read off on a scale, and the longer we have to make the gap before the current will pass through the tube, the harder the tube, and vice versa. Too soft a tube is useless, because the rays emitted do not have sufficient penetration. Too hard a tube gives a thin, flat negative, the penetration being so great that there is not sufficient

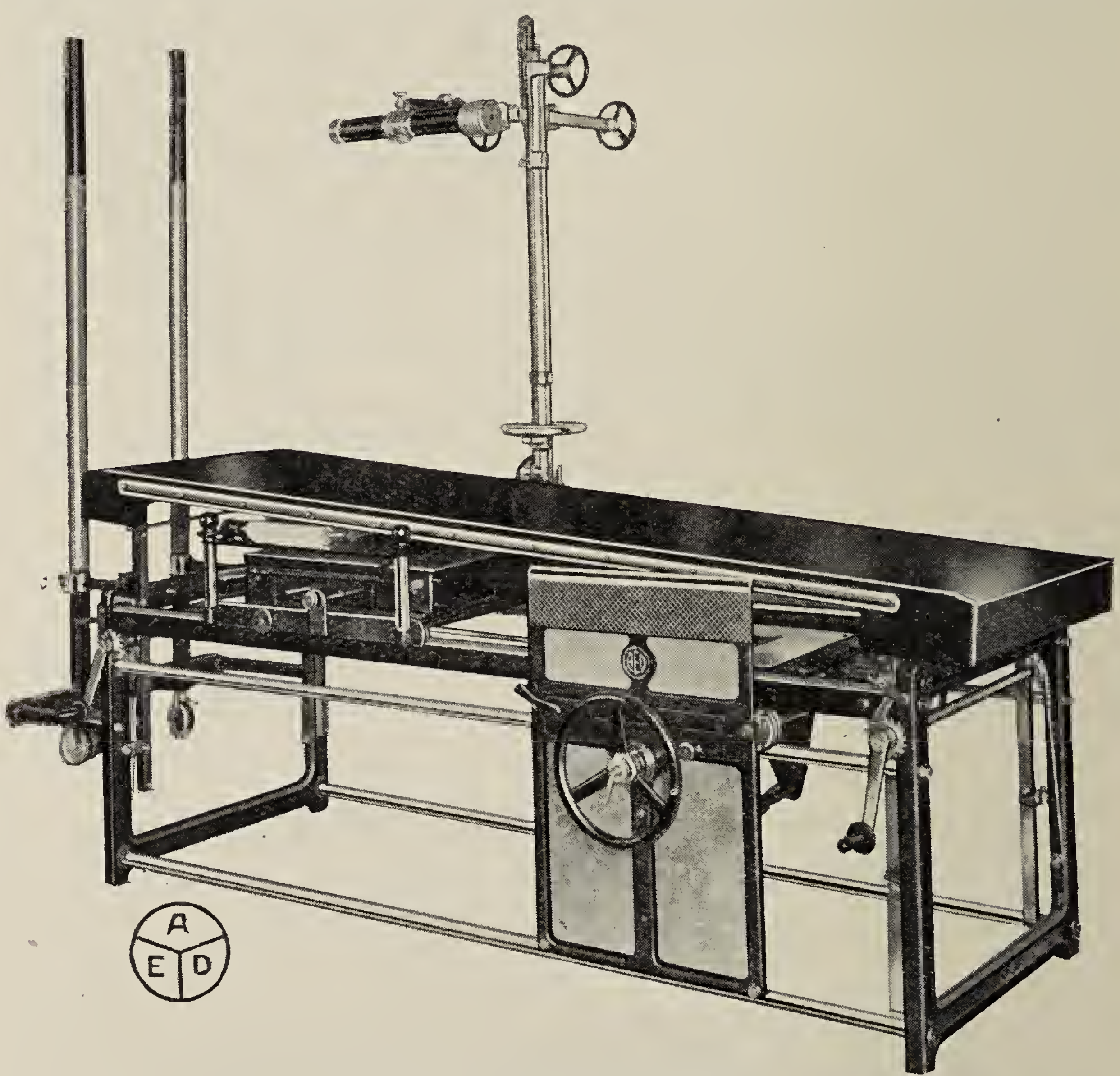


Fig. 334.—UNIVERSAL TYPE COUCH.

differentiation between the hard and soft parts. When the voltage has been determined in this way, the milliampèremeter is very convenient for detecting slight changes in the resistance of the tube, for, providing the primary current is not altered, a decrease in the reading of the milliampèremeter indicates that the resistance in the tube is increasing, and an increase in the reading indicates that the vacuum is decreasing and the resistance becoming less. In other words, the tube is becoming softer.

Although the sphere gap is still in general use, there is now an instrument available known as the *kilovoltmeter*, and with this the

kilovolts can be read off on a scale. This instrument is only possible in the case of transformers with autotransformer control.

5. **Apparatus for Enclosing and Holding the Tube.**—The next thing required is a means of enclosing the tube and holding it in a way suitable for examination. By far the most generally useful piece of apparatus for general work is a good X-ray couch, such as the one illustrated in *Fig.* 334. The tube, enclosed in a box or other suitable device (which is not necessary if the Metalix tube is employed), can

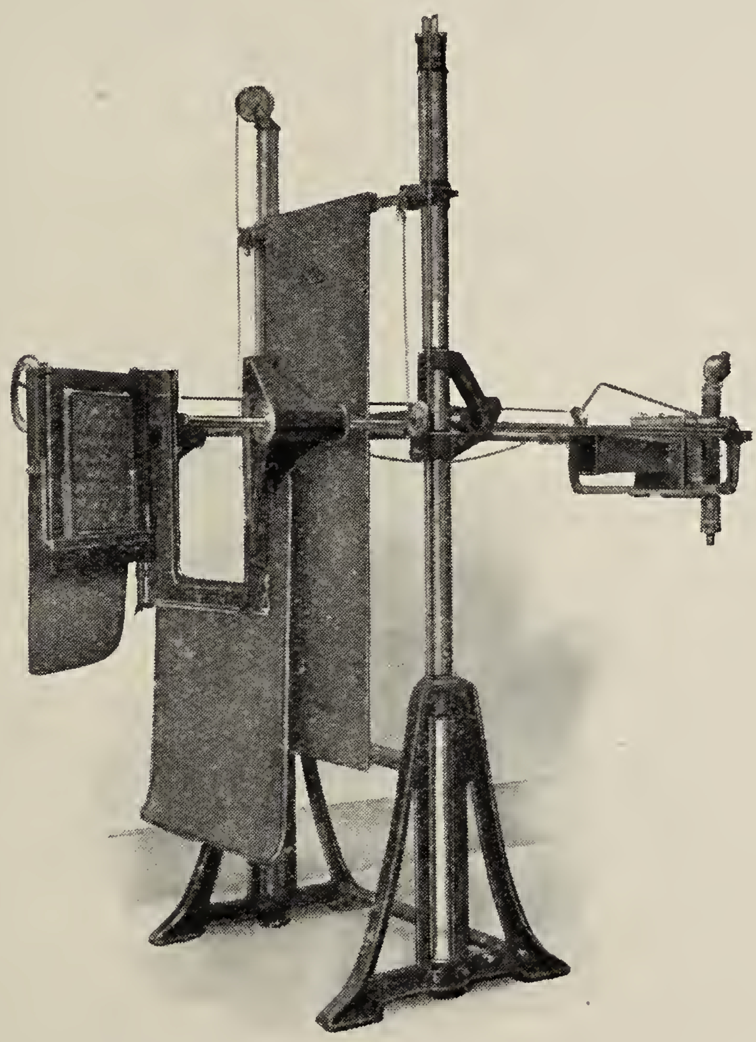


Fig. 335.—'HOLWAY' NO. 2 STAND FOR TWO-METRE DISTANCE. (SHOWING SCREEN OPEN AND CASSETTE IN HOLDER.)

be used either above or below the couch, and can be moved freely either over or under any part of the patient which it is required to examine.

An upright stand for chest and stomach work (*Fig.* 335) is also a necessity in an institution of any size. It should be possible in an up-to-date screening stand for the tube to be moved a distance of some six feet from the screen, as, in examinations of the chest, working at such a distance minimizes any distortion and exaggeration of the heart shadow. Experiments have shown that a distance greater than six feet is of no further practical value.

For X-ray treatment, and in cases where the expense of a complete X-ray couch or screening stand is a consideration, some form of tube stand, such as the pattern illustrated in *Fig.* 336, may be employed. With this it is possible to adjust the tube simply and readily in any position in relation to the patient, whether below or above him as he lies on a table, or behind or in front of him if he stands or sits as in the case of the couch and screen. These stands are provided with a lead-lined box to contain the tube, unless built for the use of Metalix tubes only. Every tube box should be provided with an adjustable diaphragm where the X rays emerge, so that the area of illumination can be limited to the exact part under examination. *Fig.* 337 illustrates such a diaphragm fitted to a Metalix tube.

6. **Fluorescent Screen.**—This consists of a wooden frame in which is mounted a piece of stiff cardboard coated with very finely divided crystals of zinc sulphide or other suitable material which has the property of fluorescing brightly to X rays. It should be covered with a lead glass opaque to the rays for the protection of the operator. Such a screen is illustrated in *Fig.* 338.

7. **Protective Apparatus.**—This consists of all the devices in use to confine the X rays to the area under examination, such as diaphragms and lead lining to boxes, finger-guards, lead-glass cover to screen, protective gloves, aprons, etc. In the early days of radiography, before it was known that X rays could produce dangerous results after repeated small exposures, these devices were not in use, and many X-ray operators were badly injured and some lost their lives. It is absolutely necessary that protective apparatus should be a

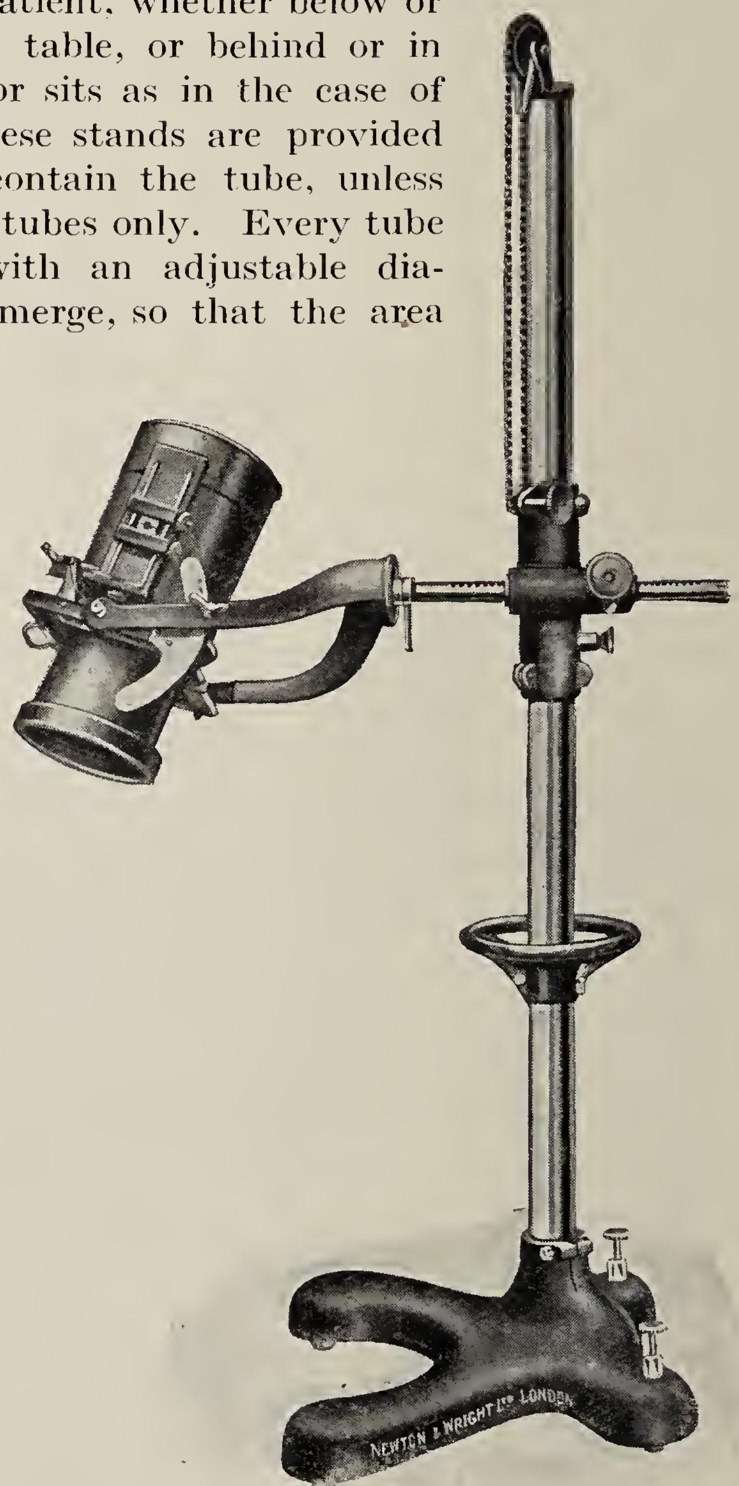


Fig. 336.—X-RAY TUBE-HOLDER, CYLINDER DIAPHRAGM, AND COMPRESSOR.

constituent part of every X-ray outfit, and a copy of the rules laid down by the X-ray and Radium Protection Committee can be obtained from the National Physical Laboratory, Teddington. This Laboratory is also prepared to test and report upon the efficiency of all protective devices, for a moderate fee.

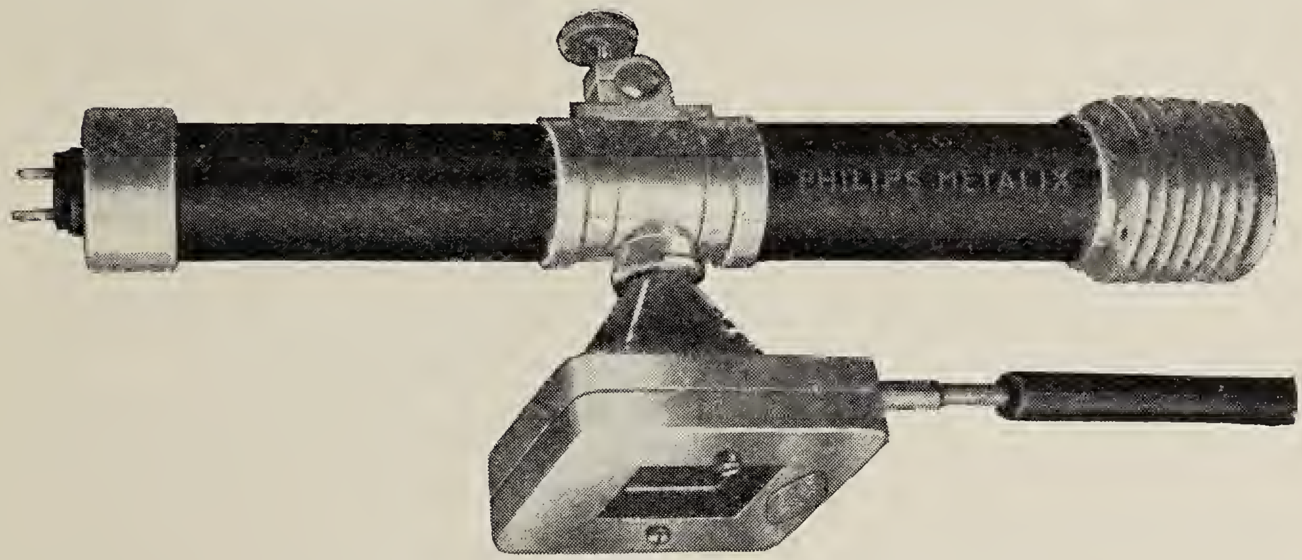


Fig. 337.—Rectangular Diaphragm for Metalix Tubes.

8, 9. A **Photographic Dark Room**, a supply of **X-ray Films, Dishes, Developers,** etc., and a suitable **Storage Cabinet,** complete the necessary outfit.

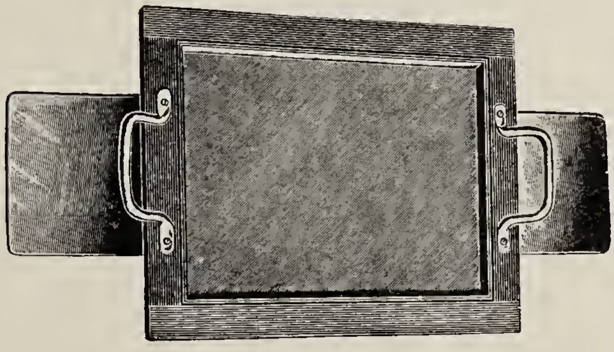


Fig. 338.—Lead-glass Screen with Metal Finger-guards

We now have everything necessary for making an X-ray examination. With regard to storage, in a large institution it is advisable to have the film store outside the main building, but smaller quantities of films may be safely stored in a suitable metal cabinet.

TECHNIQUE.

Screen Examination.—To start with, see that all the connections are correct and perfect. A loose connection may be the cause of considerable damage, and in the high-tension circuit may result in the puncturing and loss of a tube. It does not take very long to run over the connections from the source of energy to the X-ray tube.

Before making a screen examination it is advisable to remain in a darkened room for some little time, so as to get the eyes dark-adapted.

and during this time the necessary preliminaries, such as the adjustment of the sphere gap, noting the reading of the kilovoltmeter, milliampèremeter, etc., may be carried out. All necessary adjustments having been made, the patient is placed on the couch, the tube moved under the part to be examined, and the screen placed upon it ; the light is then put out, the current switched on, and the diaphragm opened to a size just sufficient to include the area under examination and no more.

The bones should now stand out clearly and sharply defined, not very black or very transparent. If the fluorescence of the screen is very dim, put on a little more current by advancing the lever which controls this current from the start or weak end, until the bones are clearly seen. Note the reading of the milliampèremeter, etc., for future reference. Do not keep the current on longer than is absolutely necessary to make an examination, and never put your hand in the path of the rays. Constant small exposures of the hand of the operator are the source of a dangerous and intractable dermatitis, as many of the pioneers of this work learned to their cost.

If a new gas tube is in use, remember that such a tube becomes too soft very rapidly if overheated. Therefore keep an eye on the milliampèremeter ; if the reading shows signs of increasing rapidity, switch off at once and allow the tube to cool ; otherwise it may be ruined. A tube once overheated takes a considerable time to recover. It is necessary, therefore, to have several, so that they may be changed as need arises without interrupting the work. New gas tubes must be very carefully nursed if we are to get the longest life out of them. A tube which has been carefully used for some time becomes what is called 'seasoned'. It will then stand a considerably larger current for a longer time than when it was new.

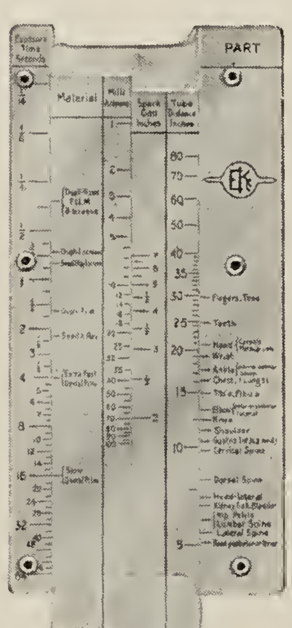


Fig. 339.—Slide Rule for Calculating X-ray Exposures.

These remarks, of course, do not apply if the hot cathode type of tube is employed, but these tubes, too, can become overheated, and one must keep within the limits of current indicated by the manufacturers with regard to each type of tube.

X-ray Photography or Radiography.—Having ascertained that the tube is working in a satisfactory manner, and having centred it under the part to be examined, the X-ray film, enclosed in a double wrapper or cassette of a suitable size to include all that is necessary, may now be placed on the part, held in position by sandbags if necessary, and a trial exposure given. Several tables are now available which give some idea of the exposure necessary (*Fig.* 339). It will be well for the beginner to use a small current and give fairly long exposures until he becomes quite *au fait* with his apparatus. More rapid work may then be attempted. The

results obtained with somewhat prolonged exposures are equally as good as, and sometimes better than, more rapid ones when dealing with parts that can be immobilized ; but for the lungs, heart, intestines, etc., the best results can be obtained only with very rapid exposures.

If it is preferred to work with the tube above the patient, this is centred over, a plate put under the part, and an exposure given as before. Whichever method is employed, it is essential that the tube be centred over the part to be examined, otherwise there will be much distortion, which may give rise to errors of diagnosis.

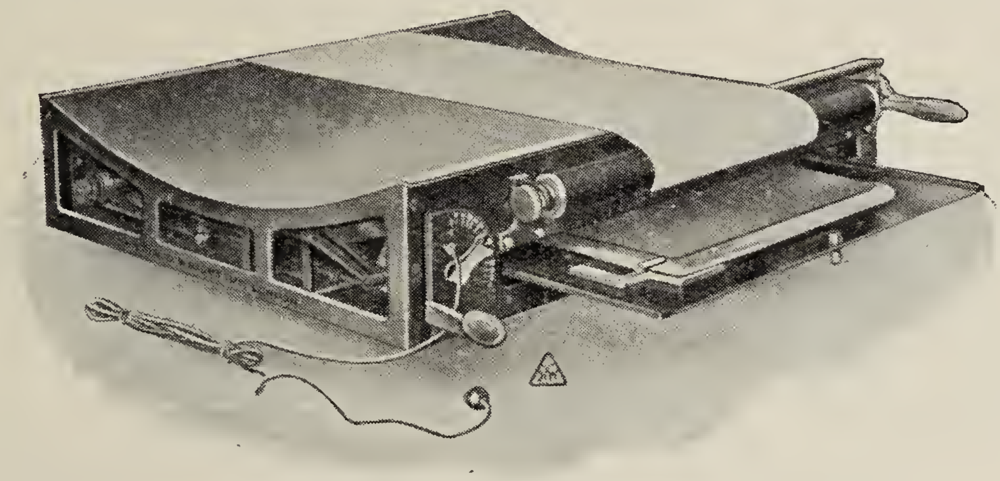


Fig. 340.—Potter-Bucky Diaphragm.

Until comparatively recently, large areas of the more opaque parts of the body, such as the pelvis and hip-joints, could not be obtained owing to the fogging of the films by scattered radiations from the body, and it was necessary to limit the areas exposed by a small diaphragm, preferably of the tubular type. This difficulty has now been overcome by the use of what is known, from the name of the originator, as the Potter-Bucky diaphragm (*Fig.* 340). With the use of this ingenious piece of apparatus, good definition of the whole of the pelvis and both hip-joints can be obtained on one film, as the scattered rays are prevented from reaching it. The Potter-Bucky diaphragm consists of strips of lead alternating with strips of wood, or hard wax, arranged in such a way that they are radial to the rays, and mounted to form a grid (*Fig.* 341). This grid is propelled by means of a strong spring to move uniformly during the exposure, between the part to be examined and the film ; a bell rings at the beginning and at the finish of the movement, and the exposure must be made between these limits. The rate at which the grid moves can be regulated according to the time of exposure.

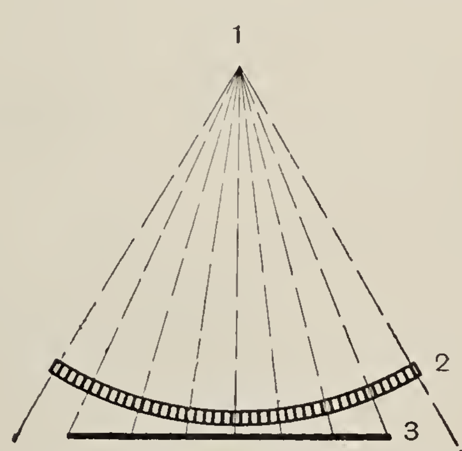


Fig. 341.—Scheme of Potter-Bucky Diaphragm. 1, Anticathode of tube; 2, Grid; 3, Film.

Stereoscopic Radiography.—By enabling us to obtain the third dimension in space, this is in some cases of great service. The method is simple, and can be carried out with the tube either above or below the patient, or on an upright stand.

The procedure is as follows : The patient is placed, say, on the couch ; and under the part to be radiographed, or above it, if the tube be below, is placed a special plate carrier which enables

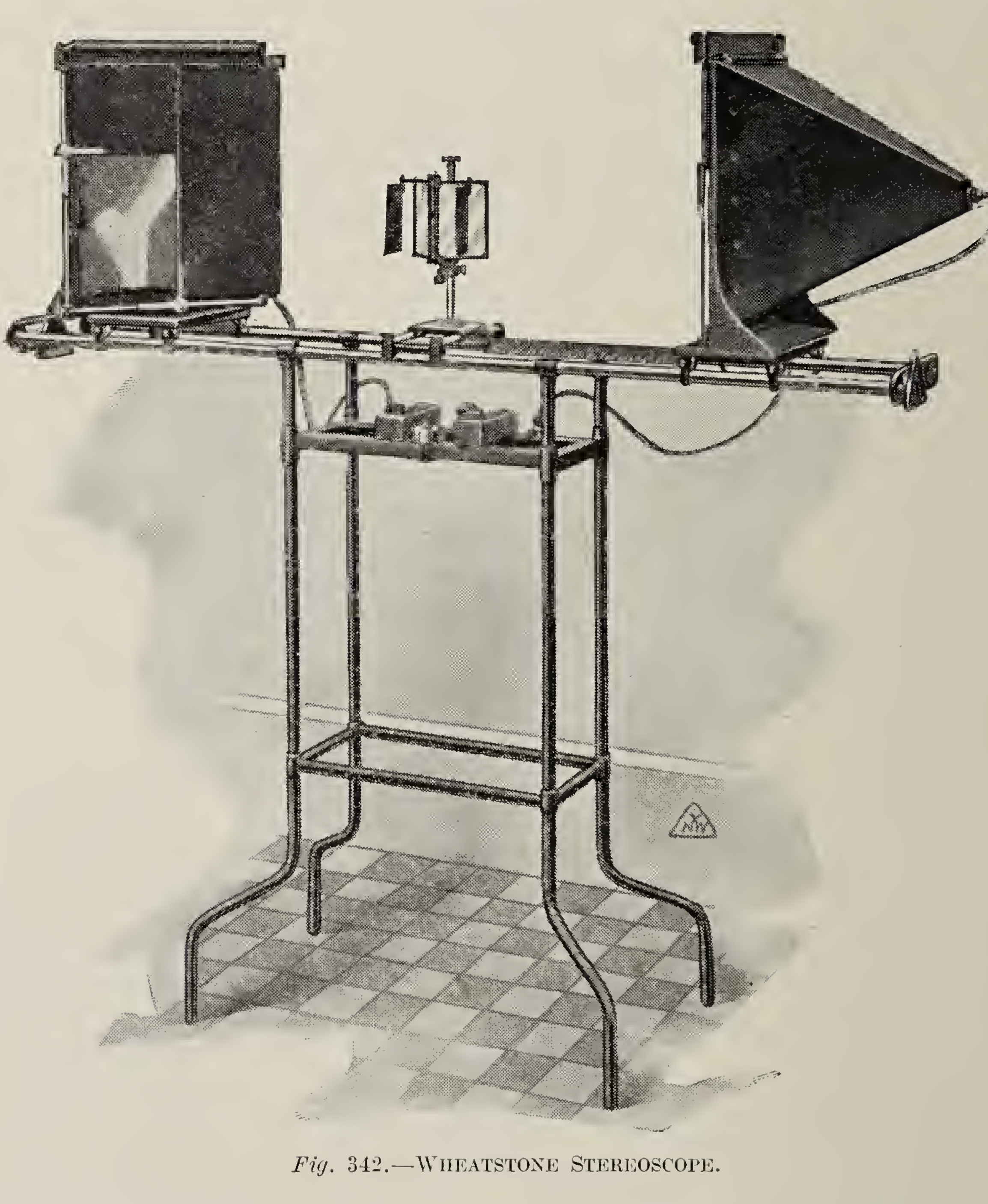


Fig. 342.—WHEATSTONE STEREOSCOPE.

plates or films to be changed without disturbing the patient. The tube is then centred accurately over the part to be examined, moved 3 cm. away from one side of the middle line, and an exposure made. The plate is then removed, another put in its place, and the tube moved 3 cm. to the other side of the middle line—that is, a total shift of 6 cm.—the average distance between the human eyes, and another exposure made.

The negatives so obtained are viewed in a 'Wheatstone' reflecting stereoscope (*Fig.* 342).

Intensifying Screens.—In all cases where very rapid exposures are necessary, use is made of intensifying screens, which reduce considerably the time of exposure (about one-fifth to one-tenth of the normal exposure). These screens are coated with calcium tungstate, a substance which fluoresces on exposure to X rays, and the usual procedure is to place a film between two of these in a specially constructed cassette.

Localization of Foreign Bodies.—During the Great European War a very large number of ingenious methods were devised for the localization of foreign bodies, their ingenuity consisting chiefly in time-saving devices rather than in any increased accuracy over the cross-thread method introduced by Sir James Mackenzie Davidson in 1898. It is impossible to describe or even enumerate all these devices in the space here available, but it will be well to explain the principle on which most of them depend. The shadow of a foreign body at some distance from the surface will move when the X-ray tube is moved, the range of movement varying with the distance of the foreign body from the surface—i.e., the further the foreign body is from the surface, the greater will be the range of movement of its shadow with a given movement of the tube ; incidentally, the shadow of the foreign body moves in a direction opposite to that in which the X-ray tube is moved.

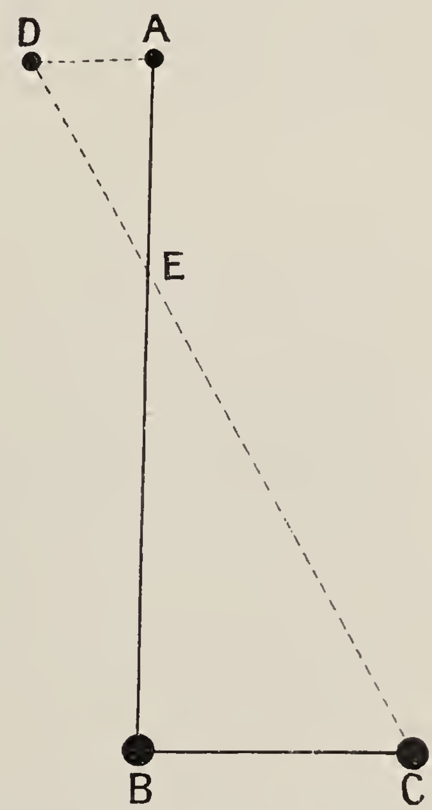


Fig. 343.— DIAGRAM TO SHOW THE METHOD OF LOCALIZATION OF A FOREIGN BODY.

Now the distance from the anticathode of the X-ray tube to the surface of the body on the opposite side to the tube can be measured ; the tube is for convenience always moved a given distance (10 cm. is that usually adopted) ; when this is done, the shadow of the foreign body will move a certain distance on the screen or plate ; this distance can obviously be measured. These data all being known, it is an easy matter to calculate the exact depth of the foreign body from the surface : Let A B (*Fig.* 343) be the distance from the anticathode to the skin, B C the known distance the tube was moved, and A D the movement of the shadow of the foreign body ; then the point E where A B and D C cross will be the position of the foreign body and A E its depth from the surface. To find the distance A E, the distance A B is multiplied by the distance A D and divided by the distance B C plus the distance A D. This calculation will not take many minutes ; but to save time, tables have been worked out and printed for a given shift of the tube, i.e., 10 cm., so that when A B and A D have been measured, the distance A E can be read off at once without any calculation.

When marking the point on the skin under which the foreign body lies, it is well to make a large cross with the ends extending beyond the field of operation, the point of intersection of the lines being immediately over the foreign body. This cross can be reconstructed at any time during the operation, by means of two long probes, their ends being placed over the lines outside the area of the incision. I need hardly add that the position of the limb or part in which a foreign body is embedded must be exactly the same at the time of operation as it was when the localization was made.

Other methods, such as two views in right-angled planes in the case of the limbs, or a stereoscopic pair of negatives, may be of more value to the surgeon in some cases than giving the depth vertically below a mark on the skin.

INTERPRETATION OF SKIAGRAMS.

A house surgeon or medical man in general practice is sometimes faced with the problem of examining an X-ray negative or print with the object of interpreting it—namely, deciding exactly what it signifies with regard to the condition of the part it depicts. This is one of the most difficult problems in radiography, and a very thorough knowledge of normal and abnormal appearances is necessary, which can only be acquired after long experience. The obtaining of a satisfactory plate is an easier matter in these days than formerly, but firms who advertise apparatus which can be worked by housemaids and children lose sight of the fact that the interpretation of the negative obtained is the important point ; hence the many victims of inexperienced radiography one hears of. Nevertheless, a few remarks as to how to proceed and what points to look out for are perhaps advisable.

When an X-ray negative is being examined, it is necessary that it should be viewed by diffused light. A sheet of opal glass forming the front of a box which contains a suitable electric light is the usual viewing apparatus ; but in the absence of this, a film can be examined by reflecting light through it at an angle from a sheet of white paper, or by holding it up to a dull grey sky.

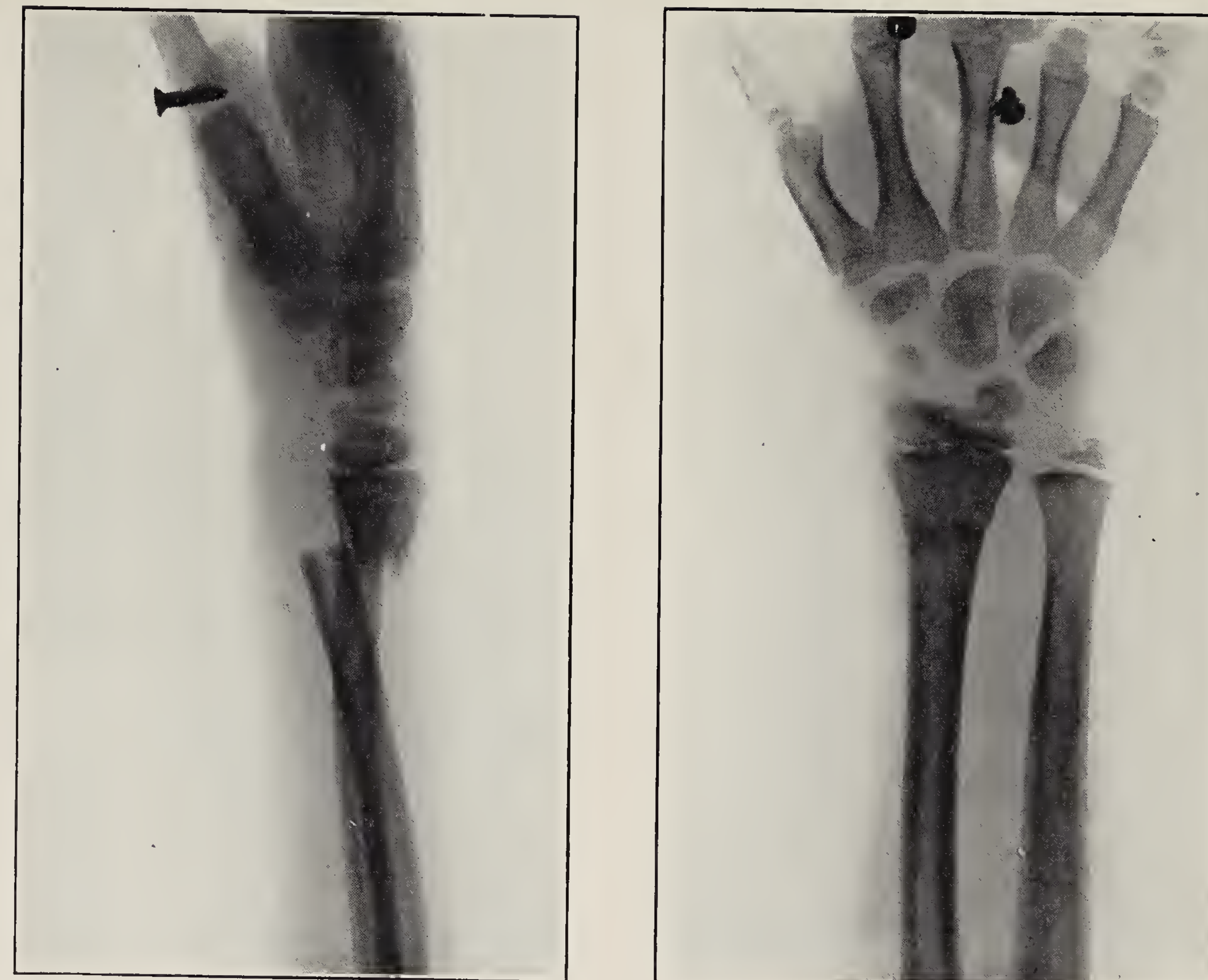
When examining a skiagram, in the case of bones and joints, first run the eyes along the contours of the bones throughout their whole length, and next examine the density of the bone substance. Normal bones and joint surfaces are clean cut and show very definite outlines, while bone tissue has very uniform and regular gradations of density. Any departure, therefore, however trifling, from a definite continuous contour, or any alteration in the normal architecture of the bone, should at once arouse suspicion (*Plate XVII, A*).

Generally speaking, as regards the long bones, it is extremely easy to say if there is a fracture and what is the position, provided that the skiagrams have been taken in two positions at right angles to each other. Conversely, it is practically impossible in most cases to say

PLATE XVII

INTERPRETATION OF RADIOGRAMS

A.—Myeloma of upper end of fibula.



B.—Antero-posterior and lateral views of fracture of lower end of radius, showing the importance of having views in two planes.

RADIOGRAPHY OF THE CHEST

Shadowing at right base due to empyema. Note typical sickle-shaped upper margin of shadow.

what is the position of the fragments from one skiagram only (*Plate XVII, B*).

In examining joints also, two views are necessary at right angles to each other wherever possible, and no judgement should be passed until both have been carefully examined. In the case of hip- and shoulder-joints, two views at right angles cannot always be taken, but stereoscopic skiagrams, and views both from behind and in front, enable a very accurate estimate to be made of the position of fractures in or near these joints.

In examining the carpus and tarsus, it is necessary to count and tick off the bones mentally by name. Omission to do this will occasionally result in failure to detect a fracture of one of the small bones such as the scaphoid in the wrist. A somewhat oblique view of the tarsus will show the tarsal bones much more spread out and separate from each other than an accurate anteroposterior or lateral view; though, of course, in doubtful cases these latter positions should be taken as well.

In examining skiagrams of suspected Pott's fracture, the lateral view is particularly important, as the antero-posterior view may show no displacement whatever, while the lateral view may show a considerable amount of displacement backwards of the lower fragments, taking the foot with them.

In cases where a fracture is strongly suspected, and the contour of the bones for any reason—say a slight tremor or movement on the part of the patient during exposure—is not absolutely clear cut, a second skiagram should always be taken, and will sometimes show a crack that was not visible in the first.

In children and young adults the epiphysial lines often present difficulties to the inexperienced, and have sometimes been mistaken for fractures. In such cases, in the absence of an expert, it will be well to examine both sides for comparison.

Medico-Legal Aspect.—It is advisable to have an X-ray examination made in every case of fracture or suspected fracture, as the Medical Defence Union and other organizations are not willing to take up the case for a doctor who has omitted to recommend this examination. If an X-ray examination is suggested to the patient, and he refuses to have it carried out, it is well to get this refusal down in writing.

X-RAY EXAMINATIONS OF SPECIAL REGIONS.

The Chest.—The X-ray examination of the chest is, in the main, medical, but the surgery of the chest is now so important that X-ray examination is often required, e.g., in the case of tumours, abscesses, empyema (*Plate XVIII*), etc. Stereoscopic examinations are often of great service, also examinations in two planes; and in order to do away with exaggerations of the shadows, chest radiograms are best taken with the tube six feet away from the film. Nothing

is gained by using a distance greater than this, as has already been mentioned.

The Gastro-intestinal Tract (*Plates XIX, XX*).—This examination is carried out by making use of the opaque meal, of which barium sulphate is the base. There are many preparations in use, but whichever is employed it is important that it should be quite smooth and free from lumps. A very good preparation is that known as 'Umbrose', prepared by Messrs. Allen and Hanburys. In the examination of the œsophagus, stomach, and duodenum, the screen examination is very important, and needs to be carried out by an experienced operator. The passage of the meal through the small intestine and colon can usually be ascertained by taking films at stated intervals. Normally, the small intestine should be empty 4 hours after the emptying time of the stomach, which, on an average, is empty in from 2½ to 4 hours after the meal. The average emptying time of the ileum is, therefore, about 8 hours after the ingestion of the meal. The passage through the colon varies within normal limits, but the average emptying time may be said to be from 48 to 72 hours. When an opaque meal is given, the passage through the colon is often what we may call fragmented, and a complete view of this part of the intestine is not always obtained. If a lesion can be located in the large intestine, an opaque enema gives a much more satisfactory view of the colon than can be obtained by a meal given by the mouth (*Plate XX*).

Preparation for Opaque Meals.—No aperient should be taken the night before the examination, and no food or drink whatever be allowed on the morning of the examination. The meal is best given at about 9 or 9.30 a.m., and the subsequent taking of food must necessarily depend on the emptying time of the stomach. It is important, in cases where an examination of the whole gastro-intestinal tract is required, that the stomach be quite empty of the opaque meal before any other food is taken. Otherwise, this will mix with the opaque residue and complicate the findings.

Preparation for Opaque Enemas.—A good aperient should be given the night before the examination, followed by a soap-and-water enema on the morning of the examination. It is extremely important that all fæcal material should be cleared from the colon before the opaque enema is given.

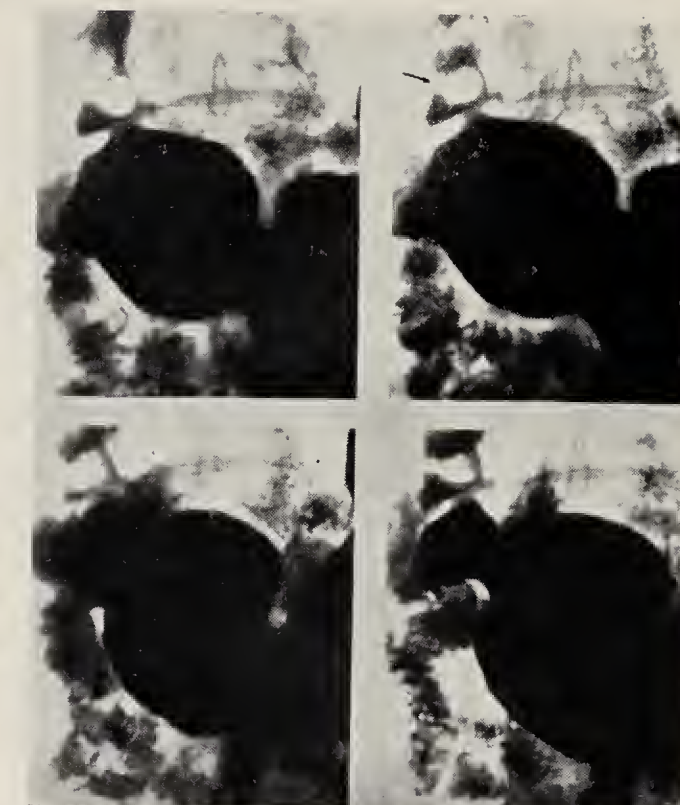
The Gall-bladder.—Until a few years ago X-ray examination of the gall-bladder was only of use for the detection of a certain small percentage of X-ray-opaque gall-stones, but recently a substance, tetraiodophenolphthalein, has been discovered which renders the gall-bladder opaque to the rays. This may be given intravenously or by the mouth, the latter method being perhaps the one most usually employed in this country at the present time. In all cases of suspected lesion of the gall-bladder a preliminary X-ray examination should be made: an aperient (not castor oil, as this produces too much gas in the intestine, but preferably the vegetable laxative pill) should be given 36

PLATE XIX

RADIOGRAPHY OF THE STOMACH AND DUODENUM

A.—Niche due to gastric ulcer in lesser curvature of stomach, with incisura due to spasm of greater curvature.

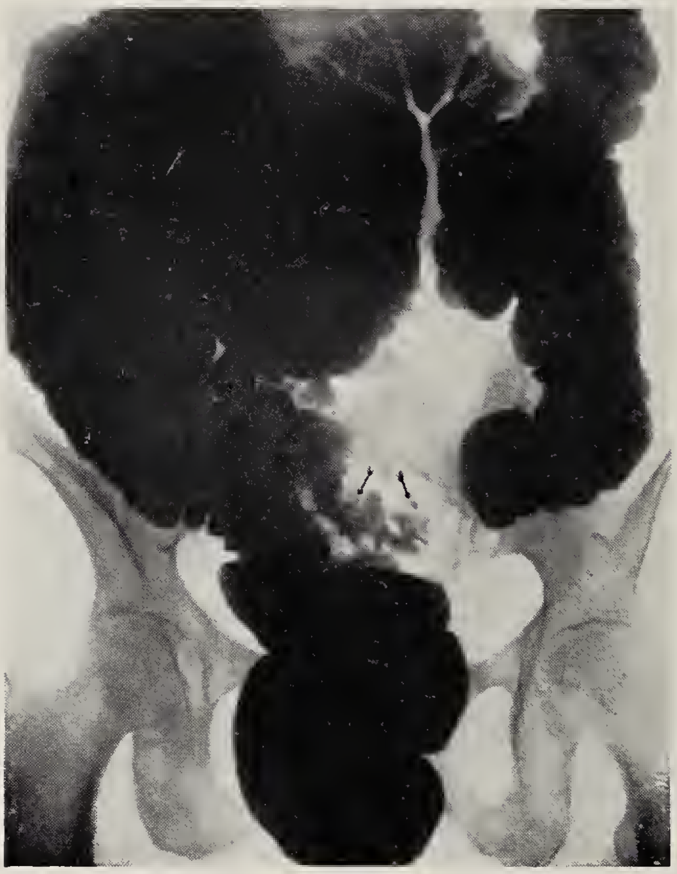
B.—Serial examination showing normal duodenal cap (first part of duodenum) with ulcer near pylorus.



C.—Serial examination showing deformation of duodenal cap typical of chronic cicatricial duodenal ulcer.

PLATE XX

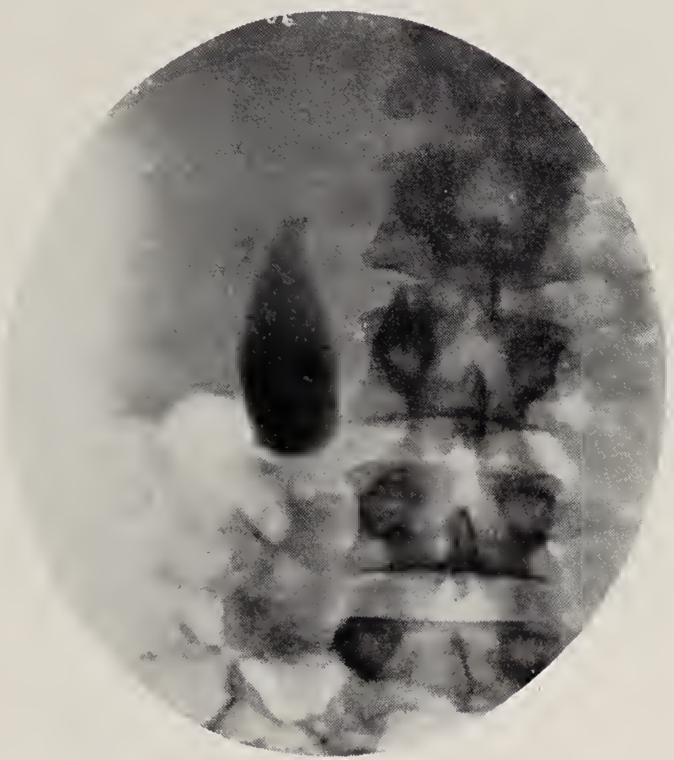
RADIOGRAPHY OF THE COLON



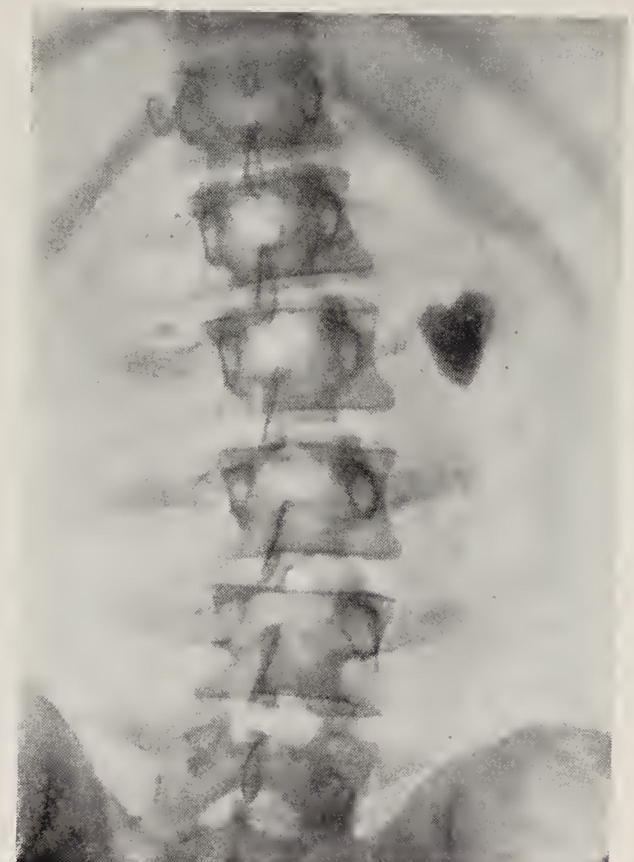
Colon after opaque enema, showing filling defect of sigmoid due to growth.

PLATE XXI

RADIOGRAPHY OF THE GALL-BLADDER AND URINARY TRACT



A.—Shadow of normal gall-bladder after oral administration of tetraiodophenolphthalein (shadocol).



B.—Calculus in pelvis of left kidney

C.—Large vesical calculus and large phlebolith.

PLATE XXII

PYELOGRAPHY

A.—Pyelogram of right kidney, showing normal pelvis and calices.

B.—Pyelogram of both kidneys, showing changes due to hydronephrosis, affecting the pelvis chiefly in the right kidney and the calices in the left.

hours before, but none the night before the examination, and then X-ray films taken both on inspiration and expiration. This examination being negative, then the dye may be given—if by the mouth, the same evening at about 9 p.m. ; if by an intravenous injection, about 9 a.m. the following morning—and examinations made at intervals according to the method employed. No food or drink may be taken after the dye has been administered until permission is given by the radiologist. In a normal gall-bladder a good shadow should be obtained—if given by the mouth, in about 14 or 15 hours after administration (*Plate XXI, A*); if given intravenously, about 3 to 4 hours after. Also a normal gall-bladder should free itself of the greater proportion of the dye about 3 hours after a fatty meal.

The Urinary Tract (*Plates XXI, B, C; XXII*).—Preparation is carried out as for gall-bladder examinations—i.e. an aperient, preferably a vegetable laxative, 36 hours before the examination, but none the night before. If no shadows are found, the result may be said to be negative. If shadows are found, then one has to decide from their character, range of movement, and position as to whether they are likely to be in or outside the urinary tract ; the most common shadows to cause confusion are calcified mesenteric glands, and on the right side gall-stones. A calcified mesenteric gland has usually a mottled or mulberry appearance, and its range of movement on respiration is, as a rule, greater than either a kidney stone or a gall-stone, and may move in any direction ; whereas a gall-stone generally moves downwards and inwards on a deep inspiration, and a kidney stone downwards and somewhat outwards. In a large number of cases a definite shadow of the kidney can be obtained, and in such cases it is easy by measurements to decide whether the range of movement of the shadow corresponds with that of the kidney. When there is a doubtful shadow on the right side a lateral view is important, as shadows due to gall-stones are always anterior to the shadows of the vertebræ, and shadows of kidney stones, except perhaps in the case of a large hydronephrosis or movable kidney, are overlapped by the shadows of the bodies of the vertebræ. In the cases of shadows in the line of the ureter, especially low down in the pelvis, where shadows due to phleboliths in the pelvic veins are common, it may be difficult to determine in some cases whether such shadows are within or without the urinary tract. In these cases the passage of an opaque bougie is of great service ; the bougie may be arrested at the level of the shadow or it may pass easily beyond it. In the latter case, the shadow is almost certainly outside the ureter. If arrested at the level, the shadow is probably a ureteric calculus ; but on two or three occasions I have seen a bougie arrested by a calcified gland lying outside the ureter but in contact with it.

Pyelography is another very useful method. For this examination the ureter and pelvis of the kidney are injected with solutions of sodium iodide of a strength of from 7 to 15 per cent ; the weaker

solution is used in cases where it is desirable to determine the position of the shadow in relation to the kidney, without the shadow of the solution being of such a density as to mask it. The stronger solution is used in cases where it is required to determine the presence or otherwise of a hydronephrosis or other abnormality of the pelvis or calices of the kidney. The pelvis or calices of a normal kidney take, on an average, 7 c.c. of solution to fill them. In the case of a hydronephrosis, of course, considerably more can be injected. The chief changes in hydronephrosis are : (1) An increase in the size of the pelvis and calices of the kidney ; (2) The extremities of the calices are club-shaped instead of cup-shaped (*Plate XXII*). In all cases a preliminary X-ray examination should be made before the injection of the solution. The same 15 per cent solution is used for rendering the urinary bladder opaque for the detection of diverticula, growths, etc. In such cases lipiodol may be used for the same purpose, but the cost is very much greater. Quite recently an intravenous method of pyelography has been made possible, by the introduction of a substance named 'uroselectan.'

X-RAY TREATMENT OR RADIOTHERAPY.

This is a very large subject, and one that can only be touched upon briefly. The X ray is a very useful and powerful therapeutic agent, but also one capable of inflicting irreparable damage if improperly applied. The quality of the ray employed and the dosage are therefore matters of extreme importance, and a very considerable experience is necessary before one can expect to obtain the best results. The beginner is not advised to attempt the work until he has thoroughly mastered his apparatus and obtained some practical instruction in a hospital, or he may buy his experience dearly.

Radiotherapy may be divided roughly into two divisions, superficial and deep. By superficial we mean the treatment of various surface lesions, chiefly skin diseases ; and by deep, the treatment of various lesions at a depth below the surface. In certain of these latter cases it is needful to use a ray of very high penetration and to pass heavy currents through the tube for long periods. In such instances very special tubes and apparatus have to be employed, a description of which is hardly within the scope of this book.

Dosage.—This is measured in two ways, known as the direct and indirect methods. Direct measurements are made, as a rule, by the changes in colour produced in certain materials by the action of the rays, these changes being compared with standard tints under standard conditions of illumination. In the indirect method the dose is given by time, with a tube which has been standardized to a certain type of apparatus at a given kilovoltage, milliampèrage, focal skin distance, filter, etc.

Protection of the Skin.—On account of the marked effect which X rays have upon the skin, it is necessary, when treating deep-seated

lesions, to protect the skin as much as possible. This can be done in two ways : (1) By attacking the lesion through different ports of entry—i.e., each dose being aimed at the lesion through a different area of the skin ; (2) By interposing filters to cut off as far as possible those rays which under ordinary circumstances would be absorbed by the skin. The filter most usually employed is aluminium, from $\frac{1}{2}$ to 4 mm. or more in thickness ; but in the case of deep or intensive X-ray therapy a metal of higher atomic weight is usually employed, such as $\frac{1}{2}$ mm. of zinc. These filters are always placed in the path of the ray between the X-ray tube and the area to be irradiated.

Treatment of Special Conditions.—A very large number of diseases have been treated by X rays, and it would be impossible to enumerate them all here. Among what may perhaps be called surgical diseases good results may be expected in exophthalmic goitre, enlarged prostate both innocent and malignant, tuberculous adenitis, myoma of the uterus, and certain malignant growths. A few words about the last will not perhaps be out of place. As a rule these cases are not sent to the X-ray department until recurrences have taken place, and in many cases the patients are in a more or less hopeless condition. Nevertheless, the improvement which follows in some of them is often very striking.

Carcinoma of the Breast.—In addition to the treatment of inoperable cases, the prophylactic treatment of carcinoma of the breast is now of proved value ; and even when recurrences have taken place, I have seen large numbers of recurrent nodules disappear and the disease kept in check for many years. So impressed have I been with the improvement in some of these cases that I am of opinion that all ought to have the benefit of a course of X-ray treatment as a prophylactic measure as soon as possible after the operation. Another effect of the rays is an improvement in the scar, which has a decidedly lessened tendency to contract. Further, the relief of pain is often very remarkable.

Epithelioma.—Cases of epithelioma are, in my experience, the least favourable, but some have cleared up considerably with the so-called intensive X-ray treatment.

Rodent Ulcer.—This yields readily, and a large percentage of cases can be cured, though there is a tendency to relapse in some.

Sarcoma.—Here again the rays have a remarkable effect. I have seen quite large masses considerably reduced, and in some cases disappear altogether. Instances of cure have even been reported ; but in the majority of cases there have been recurrences elsewhere, and the patients have eventually died from secondary deposits, although there may be no sign of the original tumour.

Hodgkin's disease is another condition where improvement is often very striking.

Intensive or Deep X-ray Therapy.—A few words of explanation as to what this means will perhaps be useful. Much of the work

which led up to it was carried out at the Erlangen Clinic in Bavaria, and a great deal has been heard about the so-called intensive X-ray treatment of malignant disease during the past few years. Special apparatus has been devised to give a much higher voltage than heretofore employed, and special tubes have been manufactured to withstand this voltage. It has been found that by employing the hardest ray obtainable and using a filter of 12 mm. of aluminium or 0·5 mm. of zinc, the radiation becomes much more homogeneous, and when this is the case a thickness of from 6 to 8 cm. does not alter the quality of the ray to any appreciable extent. There is less absorption in the intervening tissues, and lesions at a depth receive a greater dose in proportion to the skin dose than was previously possible.

Seeing that the dose which can be given at a depth is limited by the action of the rays on the skin, it will be evident that this is a decided advance in technique. Now the maximum dose which the skin will tolerate is called the erythema dose. This produces redness of the skin, which gradually changes to brown in about three weeks' time. It has been arbitrarily defined by the Erlangen workers as 100. It has been found by employing suitable measuring instruments that even with the most modern technique only 25 per cent of the dose administered over the symphysis pubis reaches the anterior wall of the vagina, a falling off of about 75 per cent. It is necessary, therefore, to direct the rays through several different areas of skin, in order to obtain an erythema dose at a depth. The dose necessary for the destruction of the ovarian cells, the so-called sterilization dose, has been very carefully worked out, and found to be 34 per cent of the erythema dose, and in practically all cases in which both ovaries have received this dose the menses have ceased permanently. This dose is made use of in the treatment of myomas and fibroids of the uterus, and also in certain hæmorrhages of the menopause, with very great success. The dosage required for the destruction of sarcoma cells is stated to be 60 to 70 per cent, and for carcinoma cells 100 per cent or more. Carcinoma cells are, therefore, by far the most difficult to destroy. The figures given for the sterilization dose have been shown to be correct, but for sarcoma and carcinoma they cannot at present be accepted except perhaps in so far as they show the relatively greater resistance of these cells, for there is no doubt that the sensitiveness of carcinoma cells, for instance, varies in different individuals.

The treatment is not without danger and is not to be undertaken lightly, any more than certain serious surgical procedures. Apart from the skin changes, it has been shown that the human body can only tolerate a certain quantity of what may perhaps be termed the X-ray poison. Small animals exposed to X rays for prolonged periods always die, and severe headaches, diarrhœa, vomiting, and even collapse have followed very massive doses in the human subject. A dose less than the erythema dose is, according to the Erlangen workers, not sufficient to destroy carcinoma ; a dose of 100 to 135 per cent

causes damage to the intestines, etc. ; the margin of safety is, therefore, in the neighbourhood of 20 per cent.

Very extravagant claims have been put forward with regard to the Erlangen so-called intensive X-ray treatment, especially in this country, which have not been substantiated. Nevertheless, great credit is due to Professor Wintz and his colleagues for an undoubted advance in technique, which was only arrived at after much patient and laborious work.

CHAPTER LIV

THE RADIUM TREATMENT OF CANCER

SINCE the last edition of this book, the radium therapy of malignant disease has made such progress that it is necessary to discuss the main features of its use.

Radium is an element which in the process of spontaneous disintegration gives off three products known as α, β, and γ rays. *α rays* represent about 92 per cent of the total energy of radio-active bodies. They have but slight penetrating power and are not used therapeutically. *β rays* have much more penetrating power than α rays. They are destructive to healthy tissue, and must be prevented, as far as possible, from entering the area of treatment. This end is attained by the use of screens, of which the best is platinum, for a thickness of 0·6 mm. will absorb 99·9 per cent of β rays. *γ rays* represent 4·8 per cent of the total energy of radium. They are very penetrating, and unlike α and β rays, which are material particles, γ rays are high-frequency vibrations. A screen of platinum of a thickness of 0·5 mm. will cut off only 6 per cent of γ rays. As these rays are never given off alone, but always with β rays, it will be seen that to obtain the required effect of the γ rays, which have a selective affinity for cancer cells, and to safeguard the tissues from the destructive action of the β rays, an exact knowledge of screenage and the length of exposure are essential, and perhaps represent the most important detail in radium therapy.

Radium is used in two forms, either as the sulphate, enclosed in needles or other containers, or as the bromide, which produces 'radon' or 'emanation' as it is called. Radium sulphate is practically indestructible, but 'radon' loses half its potency in 3·85 days, and in 14 days is almost inert. In order to obtain a persistent lethal dose during the whole period of application, radium sulphate must be used ; but radon, in spite of its diminishing powers, is of value in deep-seated growths—e.g., in the œsophagus—as it is not necessary to remove the 'seeds' in which it is contained at the end of the treatment.

Radium may be used in four ways :—

1. *By placing it in the cavity to be treated.* This is still the method in use in cancer of the uterus, combined with other methods, but has been abandoned in the œsophagus and rectum.

2. *By implantation* into or around the growth.

3. *By surface application,* the needles being attached to the outer side of a Columbia paste 'jacket' 15 mm. thick. Columbia paste

consists of equal parts of beeswax and paraffin wax (melting at 62° C.) into which, while melted, fine white wood sawdust is stirred in a proportion by weight of sawdust = beeswax + paraffin wax. This method must not be combined with implantation for fear of secondary radiation.

4. *By the bomb.* This consists of a large quantity of radium (4 grm.) enclosed in a lead container with a window which allows the rays to be directed on the patient. The distance from the patient, which must not be less than 10 cm., and the length of exposure, must be carefully calculated.

It is impossible in the space at our disposal to describe with any detail the methods of use of this potent therapeutic agent. It is enough perhaps to say that it has won its place as a valuable adjuvant to surgery, and that in certain situations—e.g., in cancer of the larynx and pharynx, and of the tongue and floor of the mouth—it bids fair to oust the knife altogether; while its use in cancer of the breast, of the uterus, and of the rectum is constantly increasing. The immediate effect in intra-oral cancer, as regards the destruction of the disease and the restoration of function, is amazing; and if results are as permanent as they are immediately effective, a great advance has been made. It is probable that for some time yet, except in the mouth and larynx, radium will be used as an aid to surgery; no one, however, can place a limit to its value. But its dangers in unskilled hands are obvious, and it would be well to confine its use to experts until experience has permitted an agreement on a safe technique.

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